Connecticut Survey Of Bridge, Culvert And Stormwater Design Practices

November 1993

US Army Corps
of Engineers
New England Division

CONNECTICUT SURVEY OF BRIDGE, CULVERT AND STORMWATER DESIGN PRACTICES

Prepared for

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EXECUTIVE SUMMARY

The State of Connecticut is concerned with the large damages that resulted from the floods of 1982, 1984, and 1992. It is believed that inadequate sizing of bridges and culverts was a significant factor in the degree of damage.

At the request of the State of Connecticut, the Army Corps of Engineers, New England Division, conducted a survey of 20 communities to assess drainage practices they utilize. A questionnaire was developed for use by Normandeau Associates, Inc., as a basis for interviews with the appropriate community officials. A summary of the drainage and floodplain regulations of the 20 communities, the federal government, and the State of Connecticut was prepared and comparisons were made.

There was found to be a great variety among the communities surveyed with regard to the level of staffing and degree of sophistication with which drainage analyses and designs are addressed. At the state level, the regulations seem, for the most part, to adequately minimize the potential for flooding resulting from land development and activities by state agencies. However, drainage regulations at the local level are quite varied and may not be adequately enforced. A developer's consulting engineer is given a lot of choice in the methods used to meet the often ambiguous goals of the regulations. In addition, the community's engineer is often allowed to use his or her discretion when determining what drainage design goals are to be met and what methods are to be employed in meeting the goals.

The following recommendations are made to assist the State of Connecticut in reducing flood damages:

1. Adoption of the Connecticut Department of Transportation Drainage Manual by all communities should be considered.

2. The computation forms developed by the DOT for gutter flow analyses and culvert design, etc., should be made available to communities, if not required for their use.

3. Communities should be made aware of the existence of any relevant stream gage data utilized by local, state or federal agencies. Also, if no data exist in a particular community, gage data from other watersheds of similar size and terrain should be supplied.

4. The Basin Stormwater Management Plans as described in the Flood Management Regulations should be developed and provided to the appropriate communities. This may allow for coordination among communities in a common watershed.

5. Designers should analyze for the more frequent storms in addition to the storms with 100-year recurrence intervals.

6. Full buildout conditions based on current or anticipated zoning should be considered when sizing drainage structures.

1.0 INTRODUCTION

This study was conducted under the United States Army Corps of Engineers Flood Plain Management Services (FPMS) program. The FPMS program is authorized under Section 206 of the Flood Control Act of 1960 (PL 86-645).

The purpose of the study is to provide a summary of bridge opening, culvert, and stormwater design standards and practices used by the communities of the State of Connecticut. A summary of design standards and practices for the conveyance of water under the Federal Emergency Management Agency's National Flood Insurance Program and for state work is provided for comparison with community standards. The resultant study is to be used by the State of Connecticut in its efforts to develop a statewide standard, policy or procedure that would reduce flood damages.

2.0 METHODOLOGY

The State of Connecticut selected 20 communities (Table 1) falling within three population-size categories to be surveyed (see Figure 1). A questionnaire, which was developed by the State of Connecticut and the Army Corps of Engineers, New England Division, was mailed to the Public Works Director of each community for review and completion. A follow-up interview was conducted at the appropriate community official's office by Normandeau Associates, Inc. At the interview, the questionnaire was reviewed, additional pertinent information was obtained, and copies of community regulations or policies governing drainage were received. The questionnaires and applicable community regulations were reviewed and summarized. In addition, federal policies governing work in floodplains and state regulations governing state work relating to the conveyance of stormwater were researched and summarized. These references are listed in the bibliography.

Table 1 is a list of the communities surveyed and the offices interviewed.

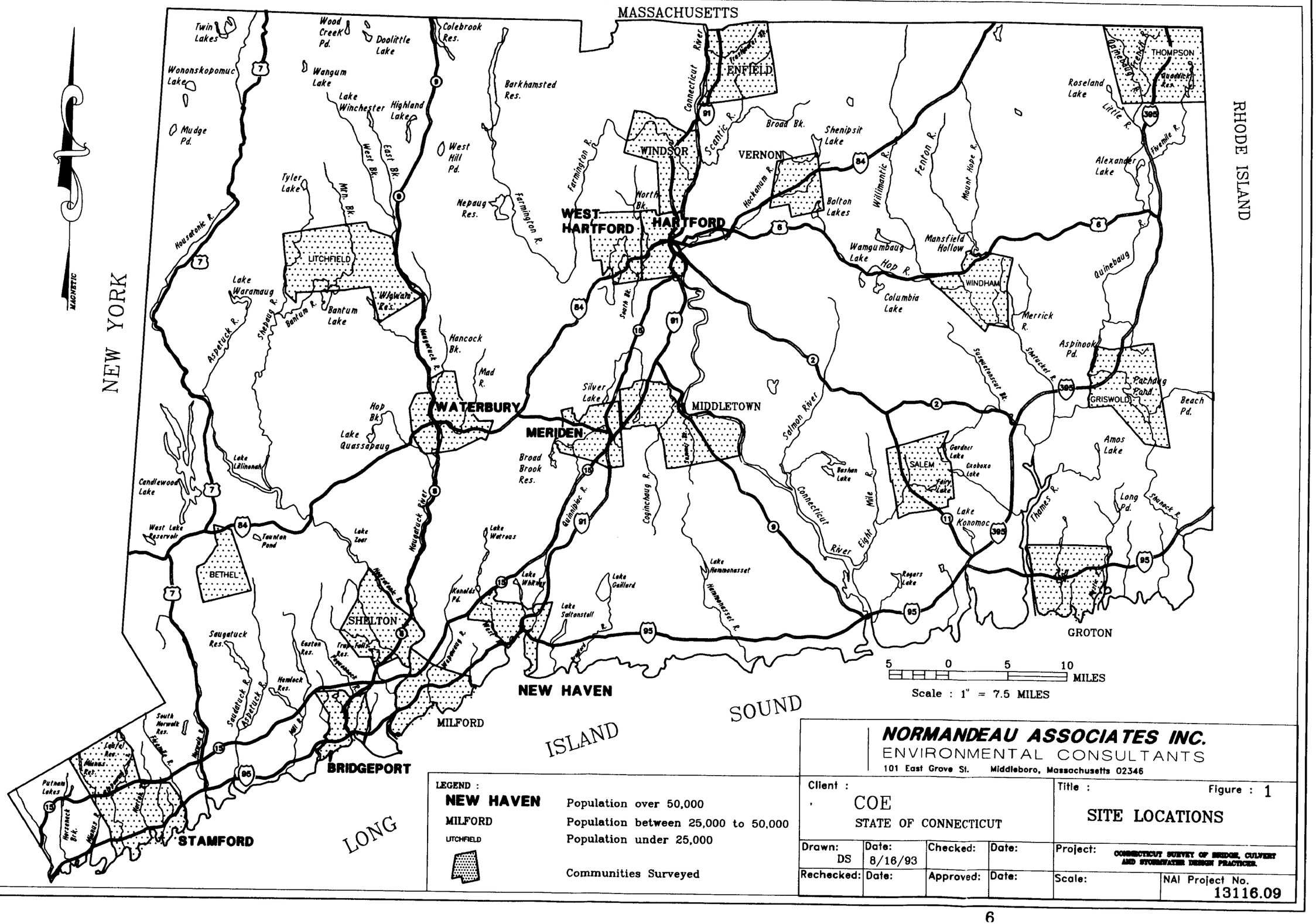
3.0 SUMMARY OF REGULATORY STANDARDS

3.1 FEDERAL STANDARDS

The National Flood Insurance Act of 1968 established a nationwide flood insurance program (the program) to provide previously unavailable flood insurance to property owners in flood-prone areas. The program was amended in 1969 and in 1973 to add mudslide protection and flood-related erosion protection, respectively. The Flood Disaster Protection Act (the Act) of 1973 requires the purchase of flood insurance as a condition of receiving any form of federal or federally related financial assistance for the purchase or construction of buildings within an identified flood, mudslide, or flood-related erosion hazard area. The Act also requires that no federal financial assistance will be provided unless the community within which the area is located participates in the program. To participate in the program a community

TABLE 1: COMMUNITIES SURVEYED	
Name of Community	Office Contacted
Town of Enfield	Public Works/Engineering Department Jeffrey Boyd, P.E., L.S.
Town of Vernon	Engineering Department and Planning Department Tim Timberman, P.E., L.S.
Town of Groton	Department of Public Works Gary Schneider, Director of Public Works Greg Hanover, P.E., Supervisor of Technical Services
Town of Salem	Hugh Teel, First Selectman Gary Caton, Road Department Gary Amt, Planning and Zoning Commission
City of Shelton	Office of City Engineer Bob Kulacz, P.E., City Engineer
Town of Griswold	Selectmen's Office Donald Burdick, First Selectman Elmer Rose, Road Foreman
Town of Thompson	Department of Public Works Moe Viens, Director of Public Works
Town of Middletown	Public Works Department Sal Fazzino, P.E., L.S., Director
Town of Windsor	Engineering Department Richard Miller, P.E., L.S. Roche Audet, P.E.
City of New Haven	Bureau of Engineering Leonard Smith, P.E. Bob Borus, P.E.

TABLE 1: CONTINUED	
Name of Community	Office Contacted
City of Hartford	Public Works Department–Engineering Division and Operations Division Thomas Johnson, Public Works Director John McGrain, P.E., Chief, Operations Division
City of Stamford	Department of Public Works Bureau of Engineering Cam Bui, P.E.
City of Milford	Department of Public Works Engineering Bureau John Casey, P.E., City Engineer
City of West Hartford	Community Services–Engineering Bill Farrell, P.E., City Engineer Dave Krauss, P.E.
City of Bridgeport	Office of City Engineer Barry Skinner, P.E., City Engineer
City of Meriden	Department of Public Works Engineering Bureau Bob Welch, P.E., Assistant City Engineer Paul Kopek, BSCE Design Review
Town of Bethel	Public Works Department Hemraj Khora, P.E., Director of Public Works and Town Engineer
City of Waterbury	Bureau of Engineering Ernest Phillips, P.E., L.S., City Engineer
Town of Windham	Public Works Department Department of Engineering Joe Gardiner, P.E., Town Engineer
Town of Litchfield	Department of Public Works David Thompson Note: Interview was not granted; however, information was supplied by town.



LEGEND :

NEW HAVEN	Population over 50,000
MILFORD	Population between 25,000 to 50,000
LITCHFIELD	Population under 25,000
	Communities Surveyed

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Client : COE
STATE OF CONNECTICUT

Title : SITE LOCATIONS

Figure : 1

Drawn:	Date:	Checked:	Date:	Project:	
DS	8/16/93			CONNECTICUT SURVEY OF BRIDGE, CULVERT AND STORMWATER DESIGN PRACTICES	
Rechecked:	Date:	Approved:	Date:	Scale:	NAI Project No. 13116.09

must adopt and submit as part of its application flood management regulations designed to reduce or avoid future flood, mudslide, or flood-related erosion damages. The program is currently administered by the Federal Emergency Management Agency (FEMA). Minimum requirements for adequate floodplain management regulations are set forth in the program regulations (44 CFR Part 60) and are described below.

Part 60—Criteria for Land Management and Use of Title 44 Code of Federal Regulations (44 CFR Part 60) describes minimum criteria for a community floodplain management plan. Individual communities may adopt more protective regulations. These regulations must be applied uniformly throughout the community to all privately and publicly owned land within flood-prone, mudslide, or flood-related erosion areas. This study will review the criteria for the conveyance of water in flood-prone areas (44 CFR Part 60.3).

Part 60.3a4i states that subdivision proposals are to be reviewed to assure that "all such proposals are consistent with the need to minimize flood damage within the flood-prone areas." Part 60.3b7 states that "when the program has designated areas of special flood hazards (A zones) by publication of a community's Flood Hazard Base Map (FHBM) or Flood Insurance Rate Map (FIRM), but has neither produced water surface elevation data nor identified a floodway or coastal high hazard area, the community shall assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained." In addition, Part 60.3c10 requires "until a regulatory floodway is designated, that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on the community's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community." The base flood is defined as "the flood having a one percent chance of being equalled or exceeded in any given year." Part 60.3c11 requires "adequate drainage paths around structures on slopes, to guide floodwaters around and away from proposed structures" within Zones AH and AO.

Alternately, Part 60.3d states that when a final base flood elevation has been provided for special flood hazard areas (A zones) and the program has provided data from which the community shall designate its regulatory floodway, the community shall implement the following regulations:

> Select and adopt a regulatory floodway based on the principle that the area chosen for the regulatory floodway must be designed to carry the waters of the base flood without increasing the water surface elevation of that flood more than one foot at any point;
>
> Prohibit encroachments, including fill, new construction, substantial improvements, and other

> development within the adopted regulatory floodway that would result in any increase in flood levels within the community during the occurrence of the base flood discharge.

The program also addresses communities that are protected from flooding by levee systems. As part of the preparation of the FIRM, FEMA determines whether a community's levee system provides protection from the base flood. For levees to be recognized by FEMA, there are a number of technical criteria that must be met that are listed in 44 CFR Part 65.10. A discussion on levee design and construction criteria is beyond the scope of this report.

The above regulations essentially require that any project for which federal funding or assistance is requested in a community participating in the National Flood Insurance Program shall not increase the extent of the flooding resulting from a storm with a 100-year recurrence interval. The technical design criteria to be used to meet the goals of the program are not provided in the regulations. The individual communities are to adopt and enforce regulations designed to meet the program goals.

In May 1977, President Jimmy Carter issued Executive Order 11988–Floodplain Management (the Order), which replaced the 1966 Executive Order 11296–Flood Hazard Evaluation. The Order is a policy initiative that links the need to protect lives and property with the need to preserve and restore natural and beneficial floodplain values. The objective of the Order is to "avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplain development wherever there is a practicable alternative. . . ." The order applies to:

> All Federal Agencies that: (1) acquire, manage, or dispose of Federal lands and facilities; (2) undertake, finance, or assist construction and improvements; and (3) conduct activities and programs affecting land use, including planning, regulating and licensing.
>
> All Federal actions described in the preceding sentence.
>
> All floodplain locations, whether they are along or near rivers, streams, oceans, ponds or related water bodies–as a minimum, areas subject to inundation by a flood with a one percent change of occurring in any year (ie., "100 year or base flood").

The Order requires that federal agencies:

> Avoid the base floodplain unless it is the only practicable alternative.

> Adjust to the base floodplain; if the base floodplain cannot be avoided, adjust to it in order to: (1) reduce the hazard and the risk of flood loss; (2) minimize the impact of floods on human safety, health, and welfare; and (3) restore and preserve the natural and beneficial floodplain values. The framework for meeting these requirements is the Water Resource Council's Unified National Program for Floodplain Management.
>
> Evaluate, design and implement all agency actions to meet the policies of the Order.

The Executive Order 11988, therefore, exerts a more comprehensive jurisdiction on floodplain activities than does the National Flood Insurance Program. The Order requires that all actions by all federal agencies or actions requiring permits from a federal agency are expected to avoid impacts on the 100-year floodplain where practicable; in other words, a project requiring a permit from the Army Corps of Engineers would be regulated under the Order. The technical means to meet the requirements of the Order are not described in the Order.

3.2 STATE OF CONNECTICUT DRAINAGE REGULATIONS

The Commissioner of the Connecticut Department of Environmental Protection (DEP) promulgated the Flood Management Regulations for State Agencies under Chapter 476a, Section 25-68h, of the Connecticut General Statutes (Appendix A). The statute and regulations require the Connecticut DEP to regulate all state activities within the 100-year floodplain, and all critical activities within the 500-year floodplain. A state activity is "any proposed state action in a floodplain or that impacts natural or man-made storm drainage facilities, including but not limited to the following:

> Any structure, obstruction or encroachment proposed for emplacement within the flood plain area;
>
> Any proposal for site development which increases peak runoff rates;
>
> Any grant or loan which affects land use, land use planning or the disposal of state properties in flood plains;
>
> Any program regulating flood flows within the floodplain."

A critical activity is "any activity including but not limited to the treatment, storage and disposal of hazardous waste, and the siting of hospitals, housing for the elderly, schools or residences in the 0.2 percent flood plain." In addition, the statue and regulations are to ensure compliance with the National Flood Insurance Program (44

CFR 59 et. seq.), any municipal zoning requirements, and stream channel encroachment lines as adopted under Chapter 446, Section 22a-342, of the Connecticut General Statutes. Following is a summary of the State regulations as they pertain to stormwater conveyance within the floodplain.

Section 25-68h 3–Stormwater Management Standards describes the requirements for on-site stormwater management and the design criteria for stormwater detention facilities, storm drainage systems, open channels, culverts, and bridges.

State activities as defined previously must prepare a stormwater management plan. The plan must indicate that the activity will minimize adverse increases in the peak flow and the volume of the runoff, and that the timing of the runoff will not cause adverse effects. The level of detail of the plan shall be commensurate with the probable impact of the project. Hydrographs must be developed for design storms with average return frequencies of 2, 10, and 100 years for both the existing and the anticipated land use conditions. Where appropriate, the hydrograph analysis shall include determination of runoff for each sub-watershed and shall address the routing of runoff through storage impoundments and floodplain storage areas, and will develop the runoff timing sequence.

Stormwater detention facilities are designed to detain excess stormwater resulting from the creation of impervious surfaces on previously pervious soils. Detention facilities serving watersheds greater than 10 acres in size shall be analyzed with hydrograph and storage routing techniques. The following design criteria are to be used:

> The release rate shall consider the existing and proposed flow rates at the site and downstream channels or structures, and the timing of runoff from other sub-watersheds within the basin of the base flood;
>
> The waters released from a detention facility shall not increase the peak flow rate at off-site downstream points unless they have adequate flow capacity for the base flood;
>
> Extended duration detention facility discharges directly into alluvial or eroding channels shall not exceed the bankfull capacity or the 2-year flood frequency flow, whichever is less, unless it is determined said channel will be stable;
>
> Section 8E of the "Connecticut Guidelines for Erosion and Sediment Control" (1985) as may be amended shall be used as a guide to construction details and materials;

An operation and maintenance schedule shall be prepared for every detention facility identifying responsibilities and items of routine maintenance, after use and emergency operations in the event of a flood.

Storm drainage systems are required to be designed in accordance with the Connecticut Department of Transportation (DOT) Drainage Manual and the following criteria:

Storm drainage systems for parking lots, driveways and roads shall be designed for 100-year frequency storms without closing use of the facility.

The use of curbing shall be minimized in order to encourage overland disbursed flow through stable vegetated areas.

The foundation drains and floor drains of buildings connected into storm drainage systems shall be designed to prevent backflow for the 100-year frequency flood into the building.

Surface runoff shall be directed through vegetated filter strips or grass swales.

Storm drains shall be extended to a suitable discharge point into a watercourse or public drainage system, or to where drainage rights have been secured.

In addition, the design of a stormwater system shall be coordinated with the National Pollution Discharge Elimination System permit program administered by the DEP, and consistent with the soil and erosion control plan, and the Public Health Code.

Open channels are classified as either Type A, local drainage channels, or Type B, natural perennial watercourses or man-made channels planned to simulate a natural watercourse. Type A channels are intended to convey urban runoff from small watercourses, frequently with intermittent flow. The design flow is intended to be conveyed within their banks. They shall be designed in accordance with the DOT Drainage Manual and the following:

Freeboard allowance shall be provided in proportion to the potential damages that could occur in the event of overtopping.

The use of impervious linings is discouraged except for very high velocity flow and steep slopes.

Type B channels shall be designed in accordance with the DOT Drainage Manual and the following where appropriate:

Shall have minimum flow capacity of a flood equal to at least 25-year frequency flood;

Shall have an inner channel to concentrate low flows with a capacity of a 2-year frequency flood;

Shall have water surface profiles prepared for the 2-, 25-, and 100-year frequency floods;

Shall consider the hydraulic capacity of floodplains;

Shall have a sediment transport capacity similar to upstream and downstream channels;

Shall be designed to minimize the use of artificial linings for flows in excess of the 2-year frequency flood;

Shall encourage ecological productivity and variety;

Shall be visually compatible with its surroundings;

Alignment and slope shall be compatible with natural channels in similar site conditions;

Variations in width, depth, invert (elevations), and side slopes are encouraged for aquatic and visual diversity;

Straightening channels and decreasing their length are discouraged;

The cross-sections used to define the channel and floodplain geometry for the water surface profile computations shall be located upstream and downstream of hydraulic structures, at changes in bed slope or cross-section shape, and generally at intervals of not more than ten times the width of the 100-year floodplain;

The friction coefficients used in the hydraulic analysis are to assume maximum seasonal vegetation conditions, and should be adjusted to the depth of flow.

All open channel work shall include a plan for channel restoration. The goals of the plan shall include the restoration and/or creation of aquatic habitats suitable for fisheries, recreation, aesthetics, flow capacity, and water quality improvement. The channel restoration plan shall include as appropriate:

Avoidance of barriers to fish movement;

Formation of pools and riffles;

Provision for areas of sheltered flow with the use of deflectors, boulders, low check dams;

Preservation of stream bank vegetation and the establishment of new vegetation;

Use of clean natural bed materials of a suitable size;

Schedule work to minimize conflicts with spawning, stocking, and fishing seasons; and

Removal of excess debris.

Other criteria for the design of open channels include the use of tractive force methods for the design of riprap as described in both the DOT Drainage Manual and the Connecticut Guidelines for Erosion and Sediment Control and the coordination with the DEP for hydraulic analysis and modification of watercourses prone to ice jams. In coastal areas, the water surface profiles of open channels shall account for the combined occurrence of tides, storm surges, and peak runoff. For watersheds with time of concentrations of more than 6 hours, the starting water surface elevation for the base flood shall be the 10-year frequency tidal surge level.

The regulations require that all culvert and bridge design undertaken as a state activity shall be designed in accordance with the methods and procedures defined in the DOT Drainage Manual. However, on local (not state or federal highways) roads and driveways, flood discharges may be allowed to cross over roads at or near the floodplain grade provided water surface elevations shall not be increased by more than 1 foot nor allowed to cause upstream damage.

In addition to the DOT Drainage Manual requirements, the following criteria shall be met where applicable:

Bridges and culverts along stocked watercourses and watercourses which may support fish shall be designed to allow passage of fish as may be recommended by the Department of Environmental Protection Fisheries and Wildlife Units.

The location of new bridges and culverts shall minimize the relocation of watercourses.

Where applicable, rigid structural floors and bridges and culverts should be depressed below the normal streambed to allow an alluvial streambed to form over them, and shall anticipate if the streambed is degrading.

The use of solid parapet walls at bridges and culverts located in the sag part of vertical curves is discouraged.

Debris barriers shall be used upstream of structures prone to blockage by debris.

The use of a single large culvert or bridge opening is preferred over use of multiple small openings.

The underclearances and maximum headwaters stipulated in the DOT Drainage Manual may be waived when decreasing the headwater depth at existing structures could increase downstream peak flows.

The Flood Management Regulations for State Agencies also require the preparation of basin stormwater management plans at the scale of the "subregional drainage basins as defined on the map entitled 'Natural Drainage Basins of Connecticut' prepared by the Department of Environmental Protection dated 1981 or as amended. Basin stormwater management plans shall include:

Watershed identification, surficial geology, and land use.

Inventory of flood hazard areas as identified by Flood Insurance Studies or the Commissioner, plus historic floods and damages.

An evaluation of watercourses, including areas of limited flow capacity, bank or bed erosion, sediment deposition, water quality, principle water uses and users, recreation areas, morphology classification, and channel stability.

An inventory and evaluation of hydraulic structures, including culverts, bridges, dams and dikes with information on their flow capacity and physical condition.

An inventory of significant flood water storage areas, including principle impoundments, floodplains, and wetlands.

A runoff hydrograph analysis of the watershed for floods of an appropriate duration, including a 24-hour event, with average return frequencies of 2, 10, and 100 years for existing and future land uses.

The relationship between the computed peak flow rates and gauging station data, with modification or calibration of the hydrographs to obtain a reasonable fit where necessary.

Identification of the peak rate of runoff at various key points in the watershed, and the relative timing of the peak flow rates.

Identification of points in the watershed where hydraulic structures or watercourses are inadequate under existing or anticipated future conditions.

Recommendations on how the subwatersheds' runoff can be managed to minimize any harmful downstream impacts.

Generalized recommendations for physical improvements for existing or anticipated future problem areas.

A copy of each Basin Stormwater Management Plan shall be filed with the DEP."

3.3 CONNECTICUT DEPARTMENT OF TRANSPORTATION DESIGN CRITERIA

The Connecticut Department of Transportation (DOT), Division of Design, Bureau of Highways, prepared a Drainage Manual, revised in January 1986, for use by all engineers involved with DOT drainage facilities. It is intended to present the best available methods, guidelines, and criteria for use in the design of DOT drainage facilities, and to ensure compliance with the FEMA and State of Connecticut floodplain regulations.

The DOT Procedures for Coordinating Highway Encroachments on Floodplains With the Federal Emergency Management Agency (FEMA) state that determination of a community's status regarding the NFIP and review of applicable NFIP maps are the first step in conducting the hydraulic studies and environmental documents required for federal aid highway actions. Coordination between the Connecticut DOT and FEMA is required when a proposed highway crossing encroaches on a regulatory floodway; a proposed highway crossing encroaches on a floodplain where no floodway has been designated and the maximum 1-foot increase in the base flood would be exceeded; detailed floodplain studies are underway for the local community; and the local community is participating in the emergency program and the base flood elevation in the vicinity of insurable buildings is increased by more than 1 foot. The DOT procedures

emphasize the requirement that, where practicable, a highway crossing shall not impact the floodway; however, if avoidance of impact to the floodway is not cost effective, modification of the floodway may be allowed. Chapter 19, Hydraulic Designs as Related to FEMA Floodways, describes the criteria by which alterations of the floodway are to be designed and reviewed.

The DOT has also prepared Operational Procedures Pursuant to the Floodplain Management Statutes and Associated Regulations (revised May 21, 1992), which essentially states that all activities undertaken by the DOT shall be in conformance with the Flood Management Statutes and Regulations (Sec. 25-68b through 25-68h, C.G.S.). The Hydraulics and Drainage Unit of the DOT shall provide design and review services to other DOT units to ensure compliance with the Flood Management Regulations for State Agencies.

As referenced in the Flood Management Regulations for State Agencies, the DOT Drainage Manual has developed standards and requirements for the design of stormwater conveyance systems. The following is a summary of the basic principles and design criteria described in the manual.

The objectives of DOT drainage designs are to "collect, control and discharge surface and subsurface water in an efficient, economical, safe and most prudent manner to provide safety to the travelling public, the hydraulic facility, adjacent properties and to preserve stream ecology." These objects can be accomplished by addressing the following:

Determining the natural points of concentration and discharge, the limiting elevations of entrance headwater, and other hydraulic controls;

Estimating the amount of storm runoff;

Estimating the amount and composition of bedload and its abrasive and bulk effects;

Determining the necessity for debris control;

Determining the requirements for energy dissipation and channel protection to prevent erosion;

Determining the necessity of providing for passage of fish and wildlife;

Analyzing the deleterious effects of corrosive soils and waters on structures;

Comparing and coordinating proposed designs with existing drainage structures and systems handling the same flows;

Providing access for maintenance operations;

Providing for the proper handling of subsurface water;

Determining the structural adequacy of pipe designs;

Determining if floodwater retention is available and if it is justifiable in terms of economics and environmental requirements, to include in the hydraulic design.

The first step in the designing of a drainage system is the determination of the size and character of the watershed in which the system is proposed. The DOT manual lists a number of sources that may contain information on soil types, ground cover, slope, land use, water use, and ecosystems. Engineering judgment is required to determine the extent of the watershed study, as it should be commensurate with the importance of the facility under design, and the wetland or watercourse receiving water from the system.

The drainage of adjacent areas under a roadway involves structures that are classified by the DOT as follows:

Minor Structures: pipes, box culverts, or bridges draining areas of less than 1 square mile in which there is no established water course;

Small Structures: pipes, box culverts, or bridges draining areas of less than 1 square mile in which there is an established watercourse;

Intermediate Structures: pipes, box culverts, or bridges draining areas larger than 1 square mile but smaller than 10 square miles;

Large Structures: pipes, box culverts or bridges draining areas larger than 10 square miles but less than 1000 square miles;

Monumental Structures: pipes, box culverts, or bridges draining areas greater than 1000 square miles;

Tidal Structures: structures of whatever type providing waterway or streams subject to tidal action and further classified as minor, small, intermediate, etc., based on drainage area.

The following are design criteria for each of the above structure categories as revised on May 21, 1992.

Minor structures are to be designed to pass the 25-year frequency storm discharge. The upstream water surface elevation at design frequency shall not cause damage to developed property.

Small structures shall be designed to pass a 50-year frequency storm discharge. The effects of a 100-year frequency storm discharge flowing through the structure shall be assessed. If water surface profiles have previously been developed for the location of the proposed structure, it shall be designed to pass the 100-year frequency storm. The upstream water surface elevation shall not be allowed to rise so as to endanger the roadway or damage private property. The elevation at the upstream highway property boundary shall not increase by more than 1 foot above the pre-construction elevation of the design storm, unless damage to developed property would occur at a lower elevation. Where the likelihood of danger to persons, extensive property damage, or more than temporary traffic interruption will exist as a result of the structure's placement, increases in waterway or other improvements shall be provided to alleviate the problem.

Culverts should be designed with the aid of Hydraulic Engineering Circulars Nos. 5 and 10 of the Federal Highway Administration (FHWA) Culvert Designs and should give careful consideration to the effect of the design water surface on abutting private property.

Intermediate structures shall be designed to pass a 100-year frequency storm discharge with a backwater usually not to exceed 1 foot and that will not cause damage to the highway or developed property upstream. The effects of the 500-year frequency storm will be assessed. If necessary because of anticipated extensive property damage or interruption of traffic flow, increases in waterway or other improvements shall be provided to alleviate the danger.

Large structures shall normally be designed to pass a 100-year frequency flow with and underclearance of generally 2 feet or more and an increase of 1 foot or less of water surface elevation at the highway property line. The elevation may be required to be reduced to avoid damage to upstream developed property.

Monumental structures shall be designed in accordance with requirements of the following state and federal agencies:

Water Resources Section of the Connecticut DEP under Chapter 446i of Title 22a of the General Statutes of Connecticut.

The United States Army Corps of Engineers under the Section 404(b)(i) guidelines (40 CFR part 230) of the Clean Water Act (33 U.S.C. 1344) and Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

The United States Coast Guard under 33 CFR Parts 1-199.

Tidal structures shall normally be designed to pass the design storm of the appropriate size class described above, unless the highway

is subject to frequent tidal flooding, in which case the design storm frequency selected may be the frequency of the tidal flooding. In addition, the effects of tidal action shall be investigated to ensure that the structure will not be damaged by scour or erosion.

Any channel relocation or reconstruction, whether or not associated with any structure construction, shall be designed to pass the flow as required by the drainage area criteria of the structure classification system described above. Adequate freeboard, generally not less than 2 feet between the design flow water surface and the edge of the travelled way, should be provided. The design flow water surface elevation on abutting private property should not be raised as a result of channel relocation without agreement from the owners. Channel bank and/or bed protection shall be provided as needed to prevent damage to adjacent property of the highway.

Open channels shall be designed to carry the design storm flow as determined by the drainage area criteria of the structure classification system. The design shall take into consideration economics, flow capacity, traffic safety, erosion control, aesthetics, and maintenance. Channels will be designed to carry the design flow within its banks unless overflow is acceptable. Designs shall minimize erosion by flattening channel grades to reduce velocity or by use of appropriate channel linings. All channels, ditches or swales will be lined as soon as they are excavated. The channel shall be designed to minimize the required maintenance. The following are specific open channel design criteria described in the manual:

Flows should be kept subcritical wherever possible.

Sediment deposition should be designed to occur at a location accessible for removal.

Hydraulic Design Series No. 4 should be consulted for methods useful in reducing velocity.

Hydrologic Engineering Center (HEC) Circular No. 15 is to be used for the design of curved channels.

The Rational Method shall be used to determine the design discharge for swales, top of slope channels, and toe of slope channels.

Hydraulic Design Series Nos. 3 and 4 and HEC Circular No. 15 are recommended for use in the design of swales, top of slope channels, and toe of slope channels.

Top of slope and toe of slope channels shall have side slopes of 3 horizontal to 1 vertical for grass linings; and 2 horizontal to 1 vertical for rigid or riprap linings.

Procedures to be used in the design of watercourse channels are also described in the manual in general terms, with references to other publications. The objectives and precautions to be taken are listed and are similar to those for channel relocation. A detailed description and worksheet are provided for the manual computation of water surface profiles. A section of the manual describes the considerations and procedures to be used in the selection of a channel lining. References and a worksheet are also provided for channel lining design.

The Drainage Manual provides design criteria and procedures for the design and construction of storm sewer systems for the drainage of roads and highways. All storm sewer systems, curbed sections, swales, and channels (not conducting a watercourse) shall be designed for a 10-year frequency storm event, with the exception of in areas with a sag curve, which will be designed for a 25-year storm.

The design of storm sewers shall be based on the following:

The Rational Formula shall be used to determine design flows.

Pipes shall be designed to flow "just full" or less than full.

Slopes shall be 0.5% to create self-cleaning flow velocities.

The Gutter Flow Analysis Form, provided in the Drainage Manual, is to be used for analysis of a drainage system that uses curbing.

The procedure for storm sewer system design and accompanying worksheet in the Drainage Manual shall be used for state projects.

The anticipated development of the adjacent land area shall be incorporated into the design flow determination.

The distance between access points via catch basins or manholes to the pipe shall not exceed 500 feet.

Pipe diameter shall be a minimum of 12 inches.

Reinforced concrete pipe shall be used for storm sewers.

Catch basins will be constructed with 2-feet deep sumps except in the case of 36 inch or greater diameter pipes that are not required to have sumps, as settling is not likely to occur in that situation.

> Inlets and other drainage structures shall conform with the details as shown in the DOT Standard Drawings manual. However, on streets to be accepted and maintained by a municipality, local standards shall be met.

In summary, the DOT Drainage Manual recognizes the variability of topography, soil types, cover types, and other factors affecting stormwater runoff characteristics, and therefore allows for a degree of sound engineering judgment to be used in the design of a stormwater conveyance system. However, the DOT also recognizes the need for the application of consistent design objectives statewide and therefore describes the objectives and provides methods to be used to meet them. The DOT also has recognized the need for consistency among the Connecticut Flood Management Regulations, the DOT Drainage Manual, and the FEMA Flood Insurance Program.

The floodplain management practices and requirements as described in the FEMA Flood Insurance Program are to be complied with by each Connecticut municipality. In order to facilitate that goal, the State of Connecticut prepared the Model Flood Damage Prevention Ordinance for adoption by municipalities at their discretion. The model ordinance provides text that is required by the FEMA regulations, along with optional, recommended, and not-recommended text. The model ordinance is included as Appendix B.

4.0 COMMUNITY SURVEY

Interviews were conducted with 19 of the 20 communities contacted. The Town of Litchfield could not find time for an interview during this study period but returned a completed questionnaire and a copy of their subdivision regulations. About 50% of the communities had completed the questionnaires prior to the interview. Completed questionnaires are provided in Appendix C.

Information on past design practices was obtained during the interview process; questions were clarified and town projects were discussed. In general, most communities have not undertaken design projects in the last few years. Projects that have gone forward are usually with federal and/or state funding and design review, or as private residential subdivisions or commercial developments. The interviews went beyond the scope of the questionnaire format in that information regarding design practices imposed upon the private developers was obtained. Most communities have developed subdivision rules and regulations regarding land development and drainage systems, but few communities dictate the methodologies to be used by the developers' design engineers in meeting design goals.

5.0 RESULTS

A comparison of federal, state, and local drainage regulations is shown in Table 2. The table is based on the questionnaire completed by each community; the values within the "local regulations" column represent the percent distribution of the 20 communities with respect to each design criteria. In many cases there was the opportunity for multiple responses, so the total of any one question could be greater than 100%.

As Table 2 illustrates, there is a great variety of drainage practices and regulations among the communities surveyed. There are a few generalities that became apparent from the survey, however. Most of the communities surveyed indicated that they have not undertaken the design and construction of any significant drainage projects in the last 15 years. However, only 20% of the individuals surveyed had been employed or were familiar with projects for the 15-year study period. The majority of officials interviewed have been in their positions for 10 years or less and, therefore, were uncertain what the previous design practices were.

All four of the community officials with knowledge of their department's activities for the last 15 years work for cities (Bridgeport, West Hartford, Hartford, New Haven). The officials in most of the cities indicated that because there was little or no undeveloped land even 15 years ago, they did not get involved with any drainage designs. The infrastructure has been in place in some cases for more than 100 years. The majority of their efforts are involved with repairs and maintenance.

Most communities have enacted subdivision bylaws and regulations in one form or another that govern the development of commercial and residentially zoned property. Any activity of the community is expected to be in compliance with the regulations also. There are specific sections in the regulations describing drainage practices to be utilized to meet minimum flood damage prevention objectives. The objectives are usually general in nature, e.g., no damage to downstream property will be allowed as a result of the development, and are nonspecific on the methods to be used to meet them. Very often a local planning board is responsible for the review of development projects and their compliance with the regulations. Communities with an engineering department usually call on that department for technical review of the proposed drainage system and any work proposed in the floodplain. Communities without engineering departments rely on the professional standards and abilities of the project's design engineer to meet the requirements of the regulations. Only 15% of the communities surveyed did not have at least one professional engineer as a municipal employee.

Of the 15% of communities without a professional engineer on staff, all were small towns (Salem, Thompson, Griswold). Some of the small towns had previously relied on state-funded programs that supplied a professional engineer to assist with any design projects. Presently, some small towns budget for outside engineering consultants to do any

TABLE 2: COMPARISON OF FEDERAL, STATE, AND LOCAL DRAINAGE REGULATIONS			
Design Criteria	FEDERAL FEMA Regulations	STATE Flood Management Regulations (Sec. 25-68h)	LOCAL Regulations (% of communities surveyed)
GENERAL			
1. Use of DOT Manual (1986) for:			
a) all drainage structures	No	Yes	50
b) all open channels	No	Yes	50
DRAINAGE STRUCTURES			
2. Types of drainage structures designed and constructed in last 15 years	Unknown	Unknown	
a) bridge			25
b) culvert			75
c) pipe			85
d) retention ponds			20
e) reservoirs			0
3. Classification of drainage structures by storm frequency	Yes	Yes	90
4. Allowable backwater	Yes	Yes	
a) 0 feet			65
b) 6 inches			10
c) case-by-case basis			25
5. Method used to determine expected design runoff	No single method		
a) Rational Method		Yes	75
b) SCS TR55			40
c) SCS TR20			35

TABLE 2: CONTINUED

Design Criteria	FEDERAL FEMA Regulations	STATE Flood Management Regulations (Sec. 25-68h)	LOCAL Regulations (% of communities surveyed)
5. d) USGS Method		Yes	5
e) HEC-1			10
f) SCS National Engineering Handbook		Yes	5
g) New England Hill and Lowlands			5
h) Comparable gaged streams		Yes	5
i) Not specified; left to engineer	Yes		35
j) FWHA Method		Yes	0
k) None			5
6. Stream gage data are used in drainage calculations	Yes	Yes	0
7. Extent that high water marks are used to verify correctness of design	Assumed yes	Assumed yes	
a) None			80
b) Seldom			20
OPEN CHANNELS			
8. Types of open channel designed and constructed in last 15 years	Unknown	Unknown	
a) Top of slope channels			15
b) Toe of slope channels			20
c) Outlet channels			45
d) Swales			45
e) Dissipators			20

TABLE 2: CONTINUED			
Design Criteria	FEDERAL FEMA Regulations	STATE Flood Management Regulations (Sec. 25-68h)	LOCAL Regulations (% of communities surveyed)
9. Methods used to design open channels	Not applicable		
a) SCS National Engineering Handbook			20
b) Hydraulic Design Series Nos. 3 and 4		Yes	15
c) Federal Highway Administration Method			5
d) HEC-2			15
e) CT Erosion and Sediment Control Guide			10
f) Seelye Design Handbook			5
g) Design engineer's choice			35
h) None			20
10. Designs include water surface profiles	Yes	Yes	50
11. Designs include freeboard	Not specified in sources reviewed	2 feet	
a) 6 inches			5
b) 1 foot			55
c) case-by-case basis			15

TABLE 2: CONTINUED

Design Criteria	FEDERAL FEMA Regulations	STATE Flood Management Regulations (Sec. 25-68h)	LOCAL Regulations (% of communities surveyed)
STORMWATER SYSTEMS			
12. Method of analysis to determine design flows	Not specified in sources reviewed		
a) SCS TR20			30
b) SCS TR55			45
c) Rational Method		Yes	90
d) Engineer's choice			30
e) Gutter flow analysis		Yes	5
13. Stormwater analyzed at:			
a) Structural level		Yes	10
b) Drainage basin basis	Yes	Yes	90
14. Conveyance systems are categorized by size of event	Yes	Yes	85
15. a) Construction standards minimum pipe diameter	Not applicable		
Mains 12 inch		Yes	10
15 inch			75
18 inch			5
determined by DOT Stormwater Worksheet			5
Connectors 6 inch			5
12 inch			10

TABLE 2: CONTINUED

Design Criteria	FEDERAL FEMA Regulations	STATE Flood Management Regulations (Sec. 25-68h)	LOCAL Regulations (% of communities surveyed)
15. b) Catch basin spacing Maximum distance	Not applicable		
200 feet			5
300 feet			55
400 feet			5
500 feet		Yes	0
Determined by gutter flow analysis		Yes	30
16. Types of erosion control used	Not applicable		
a) CT Erosion and Sedimentation Control Guidelines		Yes	50
b) Sedimentation dikes and pools		Yes	35
c) Traps		Yes	25
d) Haybales and silt fence		Yes	60
e) Inland Wetland regulations			50
f) Chemical stabilizer		Yes	5
17. Has design standards that have been reviewed by outside party	No, based on sources reviewed	No, based on sources reviewed	0
18. Has design document format for follow-up on design adequacy	No, based on sources reviewed	No, based on sources reviewed	0
19. Has had problems with drainage structures listed above	Unknown	Unknown	70

design of town projects and for review of significant development projects. The small towns are generally less apt to have specific regulations regarding the criteria for a drainage system, methodology for development of design flows, spacing and sizing requirements for catch basins and stormwater piping, etc. A number of small towns sorely miss the state-funded engineering services they had received in the past.

As Item 19 of Table 2 indicates, 70% of the communities surveyed have experienced problems with drainage systems. Table 3 lists the nature of the problems described by each community.

The problems listed in Table 3 were 11 times more likely to be a result of inadequate design and maintenance than a result of poor construction. It is beyond the scope of this report to determine whether the problem designs were based on regulations that have since been revised, or were in compliance with current regulations.

Some of the observed flooding may be attributable to specific design criteria in the DOT Manual. For example, Section 11.05 regarding drainage structures allows for various degrees of flooding beyond state property and onto private property. By design, an increase in water surface elevation up to 1 foot is allowed, unless it would cause damage to developed property. However, this criteria does not take into account the development of the private property after the drainage structure has been installed. The private property owner is not likely to be aware that his/her property may be flooded by design.

Section 15.00 of the DOT Manual specifies the use of corrugated metal pipe as stormwater conduit. A lot of communities have found corrugated metal pipes deteriorate and much of their maintenance budget is spent replacing them.

The Connecticut Model Flood Damage Prevention Ordinance recommends in Section 4.4.1.9 that base flood elevation data be provided for developments of 5 acres or more. This may allow smaller parcels to be developed without the benefit of regulatory review and may result in incremental development within the floodplain, the cumulative result of which may be an unanticipated increase in base flood elevation. Section 5.2 of the Model Ordinance may also allow for incremental development of the floodplain with the unanticipated cumulative effect of raising the base flood elevation. Flood elevations resulting from more frequent storms are also likely to rise as the smaller parcels are developed.

Most of the communities stated that although they may be able to identify problems with their stormwater systems, there was little funding to replace them. Generally, drainage structures are replaced only as they fail. A number of communities have, or are in the process of, enacting policies or regulations governing stormwater drainage systems. The City of Waterbury has commissioned a study of the drainage patterns that would result from a 25-year storm event under full buildout conditions. The study will identify potential and existing flooding problems.

TABLE 3: DRAINAGE PROBLEMS WITHIN COMMUNITIES INTERVIEWED				
	Causes of Problem			
Community	Design	Construction	Maintenance	Description of Problem
Bethel	✓			New drainage systems designed for 25-year storms tie into and exceed capacity of old drainage sytems designed for 10-year storms.
	✓		✓	No longer allows stormwater runoff discharge to dry wells due to clogging.
Bridgeport	✓			Flooding of Ox Brook and Island Brook are result of past lack of design standards and regulations.
Enfield			✓	Poor detention basin maintenance.
	✓			State-sponsored widening of Shaker Road is considered to be likely to increase flooding.
Griswold	✓		✓	No longer allows stormwater runoff discharge to dry wells due to clogging.
Hartford			✓	Lack of catch basin cleaning.
Milford	✓			Undersized culverts used to convey perennial streams.
New Haven			✓	Lack of catch basin cleaning.
Salem	✓		✓	Open swales tend to erode; 10% slopes as allowed are too steep.
Shelton			✓	Detention pond malfunction due to clogged outlet pipe.
Stamford	✓			Culvert overtops after 5-year storm.
	✓		✓	No longer allows stormwater runoff discharge to dry wells due to clogging.

TABLE 3: CONTINUED				
	Causes of Problem			
Community	Design	Construction	Maintenance	Description of Problem
Thompson	✓			Problem with culvert designed by the Soil Conservation Service.
Vernon	✓		✓	No longer allows stormwater discharge to dry wells due to clogging.
Waterbury	✓			Flooding of open channels and stormwater systems due to inadequate review.
		✓		Flared end sections separate from culvert.
			✓	Lack of catch basin cleaning.
West Hartford	✓		✓	Has problem with frequent flood resulting from DEP management of three flood reservoirs.
TOTALS (Percent)[a]	11 (78%)	1 (7%)	11 (78%)	

[a]Percent of those communities reporting problems with drainage stuctures.

Most of the communities along the major rivers (Enfield, Windsor, Hartford, Middletown, Shelton, Vernon) recognized the impact of upstream development on flood levels of the river. They expressed concern that the uncoordinated release of stormwater from detention facilities throughout the watershed could inadvertently be timed to cause a number of peak flows to coincide at a point in time, exacerbating flooding problems along the river. The City of Hartford belongs to the Greater Hartford Flood Commission, which reviews drainage projects proposed in a number of adjacent communities. In addition, all drainage in Hartford ties into the Metropolitan District Commission (MDC) drainage system and is subject to its regulations, and there is some coordination among the City of Hartford's Engineering Department, the Greater Hartford Flood Commission and the MDC. However, the communities on the river do not have the resources to coordinate their drainage analyses and designs on a Connecticut River watershed basis.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The Connecticut DOT Drainage Manual is the most comprehensive of the references reviewed in that it provides drainage design objectives and methods to meet the objectives. It addresses a number of concerns, including wildlife and water quality, and would make a good basis for local community regulations. Incorporation of, or references to existing Best Management Practices for the treatment of urban runoff should be considered in future additions of the DOT Manual and local regulations.

The following is a summary of the conclusions drawn from the survey:

- The cumulative impact from the incremental development of small parcels of land within a watershed is generally not addressed by current regulations of the federal, state and local agencies.

- Future land use or the full buildout scenario is generally not factored into drainage structure design; therefore, designs that may be adequately designed for current conditions may fail shortly thereafter due to building booms such as occurred during the early 1980s.

- Most communities have not undertaken design or construction of any significant drainage structures within the last 15 years. Most of the development has been as private-residential or commercial projects designed by private consultants.

- The small towns were least likely to specify drainage system design objectives and methodologies to meet the objectives. Small towns were more apt to rely on outside consultants to review a project for compliance with regulations or objectives.

- None of the riverfront communities is able to actively coordinate storm drainage system peak discharges with other upstream or downstream communities in order to avoid superimposition of peak flows at a point in time on the river.

- The Rational Method is the most common method used to determine peak flow rates.

The following recommendations may be useful in developing a statewide policy or practice to reduce flood damages:

1. Adoption of the DOT Drainage Manual by all communities should be considered.

2. Given the current federal interest in improving the quality of stormwater as evidenced by the NPDES stormwater discharge program, water quality structures or design features such as wet ponds or infiltration trenches should be incorporated into drainage regulations. Best Management Practices for the treatment of urban runoff such as those listed in "Controlling Urban Runoff: A Practical Manual for Planning and Designing BMPs," by the Metropolitan Washington Council of Governments, should be incorporated into drainage regulations. Drainage and urban runoff water quality issues should be considered simultaneously at the design phase of a stormwater drainage system.

3. The computation forms developed by the DOT for gutter flow analyses and culvert design, etc., should be made available to communities, if not required for their use.

4. Communities should be made aware of the existence of any relevant stream gage data utilized by local, state or federal agencies. Also, if no data exist in a particular community, gage data from other watersheds of similar size and terrain should be supplied.

5. The Basin Stormwater Management Plans as described in the Flood Management Regulations should be developed and provided to the appropriate communities. This may allow for coordination among communities in a common watershed.

6. The current practice of removing woody plants and cutting the grass in vegetated swales is in conflict with water quality goals. Generally, vegetated swales are designed to convey stormwater runoff as quickly as possible, which requires continual mowing. Often, the argument for mowing swales seems to be based solely on aesthetics. Swale design should anticipate a naturally vegetated condition and make use of appropriate coefficients of friction when determining the swales capacity. The

apparently conflicting goals of stormwater management and improved water quality can be resolved at the design stage of a project. However, slower runoff velocities reduce erosive forces on the channel, and allow for sediment and pollutants to settle out of the runoff and either absorb or adsorb into the swale bottom prior to discharge to the receiving water. Therefore, the concept of allowing grass swales to grow into naturally vegetated swales may want to be considered in light of reduced maintenance costs and improved water quality.

7. Designers should analyze for the more frequent storms in addition to the storms with 100-year recurrence intervals.

8. Full buildout conditions based on current or anticipated zoning should be considered when sizing drainage structures.

BIBLIOGRAPHY

Bridgeport, City of. Chapter 19A: Soil Erosion and Sediment Control Regulations. Bridgeport, CT.

Connecticut Department of Transportation, Division of Design, Bureau of Highways. Drainage Manual. January 1986.

Enfield, Town of. Subdivision Regulations. Enfield: Enfield Planning and Zoning Commission, 1992.

Federal Emergency Management Agency (FEMA). Answers to Questions About the National Flood Insurance Program. Washington, DC: FEMA, 1992.

_____. Further Advice on Executive Order 11988—Floodplain Management. Washington, DC: FEMA, 1987.

_____. National Flood Insurance Program and Related Regulations. Washington, DC: FEMA, 1987.

Griswold, Town of. Inland Wetlands and Watercourses Conservation Commission Regulations. Griswold: Griswold Inland Wetlands and Watercourses Commission, 1993.

_____. Road Ordinance. Griswold: Griswold Board of Selectmen, 1989.

_____. Subdivision Regulations. Griswold: Griswold Planning and Zoning Commission, 1990.

_____. Zoning Regulations. Griswold: Griswold Planning and Zoning Commission, 1992.

Groton, Town of. Road and Drainage Construction Standards. Groton: Groton Planning Commission, 1990.

Litchfield, Town of. Subdivision Regulations. Litchfield, CT: Litchfield Planning and Zoning Commission.

Metropolitan Washington Council of Governments. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington, DC: Author, July 1987.

_____. A Current Assessment of Urban Best Management Practices: Techniques for Reducing Non-Point Source Pollution in a Coastal Zone. Washington, DC: Author, March 1992.

Milford, City of. Engineering Guidelines for Preparation of Site Plans, Plot Plans, and Other Proposed Property Development Plans. Milford, CT: Milford Engineering Bureau, 1991.

New Jersey Department of Environmental Protection/Division of Water Resources. A Guide to Stormwater Management Practices in New Jersey. April 1986.

Rhode Island Department of Environmental Management, Office of Environmental Coordination. Recommendations of the Stormwater Management and Erosion Control Committee Regarding the Development and Implementation of Technical Guidelines for Stormwater Management. June 1988.

Salem, Town of. Design and Construction Standards: Construction and Acceptance of Roads in the Town of Salem, Connecticut. Salem, CT, 1990.

_____. Inland Wetlands and Watercourses Regulations. Salem: Inland Wetlands and Conservation Commission, 1992.

_____. Zoning Regulations and Subdivision Regulations. Salem: Salem Planning and Zoning Commission, 1992.

Shelton, City of. Subdivision Regulations. Shelton: Shelton Planning and Zoning Commission, 1978.

Stamford, City of. Requirements for Site Plan Submittal to Stamford Engineering Bureau. Stamford, CT, 1989.

Thompson, Town of. Subdivision Regulations. Thompson: Planning and Zoning Commission, 1991.

_____. Zoning Regulations. Thompson: Planning and Zoning Commission, 1993.

U.S. Water Resources Council. Floodplain Management Guidelines for Implementing E.O. 1988. Washington, DC: U.S. Water Resources Council, 1978.

Vernon, Town of. Subdivision Regulations. Vernon: Vernon Zoning and Planning Commission.

_____. Zoning Regulations. Vernon: Vernon Zoning and Planning Commission.

Waterbury, City of. Land Subdivision Regulations of the City Plan Commission. Waterbury, CT: Waterbury City Plan Commission, 1993.

West Hartford, Town of. Zoning: Chapter 177. Rochester, NY: General Code Publishers, 1990.

Windham, Town of. Public Improvement Specifications. Windham, CT.

Windsor, Town of. Construction Guidelines for Public Improvements in Subdivisions. Windsor, CT.

APPENDIX A
STATE OF CONNECTICUT
DRAINAGE REGULATIONS

ADMINISTRATIVE REGULATIONS

Regulations and notices published herein, pursuant to General Statutes Section 4-168 and 4-173, are printed exactly as submitted by the forwarding agencies. These, being official documents submitted by the responsible agencies, are consequently not subject to editing by the Commission on Official Legal Publications.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Flood Management Regulations for State Agencies

Section 1: The Regulations of Connecticut State Agencies are amended by adding Section 25-68h-1 as follows:

Sec. 25-68h-1. Connecticut floodplain management regulations for state agencies

(a) Definitions.

(1) As used in Sections 25-68h-1, 25-68h-2 and 25-68h-3:

"Hurricane wave wash" means the effect of wave action in a coastal flood hazard zone.

"Significant impact" means any activity that would create:

(A) A five percent increase in peak flow rates at any downstream point;

(B) A twenty percent increase in flow velocities or a change that allows a stable condition to become unstable;

(C) An activity that contributes to an unacceptable cumulative impact;

(D) Any activity that causes flooding on developed property not currently subject to flooding;

(E) An activity that could cause a downstream dam to become unsafe.

"Velocity waters" means the effect of moving water in a coastal flood hazard zone.

(2) As used in Sections 25-68h-1, 25-68h-2 and 25-68h-3. the definitions of the following terms shall be the same as the definitions in Section 25-68b of the General Statutes: activity; base flood; base flood for a critical activity; Commissioner; critical activity; floodplain; flood-proofing; freeboard.

(b) Program Certification.

Not later than one year from the effective date of these regulations any state agencies responsible for a program regulating flood flows within a floodplain shall certify in writing to the Commissioner that all such program(s) within its jurisdiction are being implemented consistent with the criteria in Section 25-68h-1, 25-68h-2 and 25-68h-3 of these regulations. The agency shall specifically describe:

(1) The procedures that will insure that prior to granting a permit or approval for any state activity subject to the regulatory jurisdiction of this program are in compliance with Section 25-68d of the General Statutes and these regulations.

(2) The procedures that will insure that the review and approval of applications for activities subject to the regulatory jurisdiction of this program are generally consistent with Section 25-68d of the General Statutes and these regulations.

(c) Certification of State Agency Activities.

(1) Any state agency proposing or undertaking any activity within or affecting a floodplain shall, as early as possible, but in no event later than 90 days prior to the date of initiating the activity, certify to the Commissioner that the activity is consistent with all applicable standards and criteria in Section 25-68d of the General Statutes and Sections 25-68h-1 through 25-68h-3, inclusive, of these regulations. Certification shall be made on a form prescribed by the Commissioner and the level of detail of the certification shall be commensurate with the size, complexity and probable impact of the activity. Certification shall include, but not be limited to, a description of the proposed activity, an affirmation that the activity is consistent with all applicable standards and critera, and, where applicable, certifications from a registered architect or engineer. Any agency providing grants or loans for an activity shall also demonstrate its ability to guarantee that all requirements of Section 25-68d of the General Statutes and Section 25-68h-1 through 25-68h-3, inclusive, of these regulations will be complied with by the person or persons receiving the grant or loan. Unless requested by the Commissioner, the background materials supporting the certification, including but not limited to plans, analyses and engineering calculations, need not be submitted along with the certification. Such background materials shall be retained by the agency proposing or undertaking any activity and shall be available for inspection by the Commissioner for a period of five years following completion of construction. The certification shall be signed by the head of the agency or his or her designated agent.

(2) Where two or more state agencies cooperate in proposing or undertaking an activity one agency may be designated to prepare the certification and to serve as a point of contact, however, the head of each agency shall sign the certification and each agency shall share the responsibility for the scope and content of the documents prepared pursuant to these regulations.

(d) Rendering a Decision.

The Commissioner shall make a decision either approving or rejecting a certification within ninety days of its receipt and shall notify the agency or agencies in writing of the decision. In the event that a certification is rejected, the Commissioner shall provide the reasons for the rejection and where possible suggestions for modifications or additional information which would make the certification acceptable. If a certification is rejected the agency or agencies having submitted it may request a hearing pursuant to Section 4-177 of the General Statutes.

(e) Revocation.

If the Commissioner determines after approving a certification for an activity, critical activity or program that the agency or agencies which submitted the certification failed to comply with the provisions of Section 25-68d of the General Statutes or these regulations, then the Commissioner may revoke approval of the certification. Such revocation shall be in writing and provide the reasons for the revocation and where possible suggestions for modifications or additional information which would make the certification acceptable.

(f) Exemption.

Any state agency or agencies proposing or undertaking an activity within or affecting the floodplain may apply to the Commissioner for exemption from the provisions of subsection (b) of Section 25-68d of the General Stat-

utes and Sections 25-68h-1 through 25-68h-3, inclusive of these regulations in accordance with subsection (d) of Section 25-68d of the General Statutes.

Section 2: The Regulations of Connecticut State Agencies are amended by adding Section 25-68h-2 as follows:

Sec. 25-68h-2. Floodplain management standards

(a) All state activities shall conform to the Federal Emergency Management Agency National Flood Insurance Program requirements, specifically Part 60 - Criteria For Land Management and Use, Subpart A Sections 60.3, 60.4 and 60.5.

(b) The following restrictions shall pertain to all new and substantially improved structures located within the floodplain.

(1) Structures shall not be designed for human habitation unless elevated with the lowest floor one foot above the level of the base flood.

(2) Structures and all stored materials which may result in damage to other structures, restriction of bridge openings or other narrow sections of the stream or river shall be anchored or restrained to prevent them from floating away.

(3) Service facilities such as electrical and heating equipment shall be constructed at or above the elevation of the base flood or floodproofed with a passive system.

(4) Structures located within a "coastal high hazard area" as defined in 44 CFR Part 59 shall be elevated on adequately anchored pilings or columns and securely anchored to such piles or columns such that the lowest portion of the structural members of the lowest floor (excluding the pilings or columns) is elevated to one foot above the base flood and certified by a registered professional engineer or architect that the structure is securely anchored to piling or columns in order to withstand velocity waters and hurricane wave wash.

(5) No new structures shall be permitted on undeveloped coastal barrier beaches as designated by the Federal Emergency Management Agency (FEMA).

(6) All water supply equipment shall be designed to prevent flood waters from entering and contaminating the system.

(7) All sanitary sewer collection systems located in the floodplain must have watertight manhole covers and if equipped with vents, shall extend above the elevation of the base flood.

(c) The following restrictions shall pertain to all filling, dumping, construction, excavating, and other activities which change the topography within the floodplain.

(1) No filling, dumping or construction or other activity shall be allowed which would increase the elevation of the base flood by more than one foot or adversely affect the hydraulic characteristics of the floodplain unless the proposed filling is fully compensated for by excavation in or contiguous to the filled area.

(2) No filling, dumping, construction or excavation will be allowed if these changes will result in a concentration of the natural flow of water such as to cause or increase drainage, erosion or sediment problems.

(3) Any fill placed in the floodplain shall not be greater than that which is necessary to achieve the intended purpose as demonstrated by a plan showing the uses to which the filled land will be put and the final dimensions of the proposed fill or other materials.

(4) Such fill or other material shall be protected against erosion as discussed in the Connecticut Guidelines for Soil Erosion and Sediment Control (1985), as may be amended.

(5) Any activity within a floodway designated by FEMA which would result in an increase of the elevation of the base flood or ten year flood profile is prohibited.

(6) The placement of fill in areas of high velocity flow or at the outside edge of a migrating river bend is discouraged.

(d) The following restrictions shall pertain to the storage of materials and equipment within the floodplain.

(1) The storage of materials that are buoyant, hazardous, flammable, explosive, soluble, expansive radioactive or which could be injurious to human, animal or plant life is prohibited below the elevation of the base flood for a critical activity.

(2) Other material or equipment may be stored below the elevation of the base flood for a critical activity provided that such material or equipment is not subject to major damage by floods, and provided that such material or equipment is firmly anchored, restrained or enclosed to prevent it from floating away.

Section 3: The Regulations of Connecticut State Agencies are amended by adding Section 25-68h-3 as follows:

Sec. 25-68h-3. Stormwater management standards

(a) On-site stormwater management.

(1) The stormwater management plans for state activities shall be prepared so as to minimize any adverse increases to the peak flow rate, the timing of runoff and the volume of runoff. Hydrology studies shall be conducted at a level of detail commensurate with the probable impact of the project.

(A) A complete runoff hydrograph evaluation is required for (i) Basin Stormwater Management Plans pursuant to Section 25-68h-3 (h), (ii) Stormwater management plans for project sites resulting in significant impacts, and (iii) other state activities and critical activities as determined by the Commissioner. Hydrograph evaluations shall be conducted for existing and anticipated land use conditions for storms with average return frequencies of 2, 10 and 100 years. Where appropriate, the hydrograph analysis shall include determination of runoff for each subwatershed and routing runoff through storage impoundments and floodplain storage areas. The timing sequence of the runoff must be fully developed.

(B) Where suitable records exist, hydrographs should be developed from historic gauged flood data. For other watercourses, the hydrographs shall be developed from deterministic rainfall-runoff techniques and compared with flood flows of similar gauged watersheds and an assessment made as to the need to calibrate the hydrograph based on this comparison.

(2) Stormwater management plans for project sites shall be coordinated with Basin Stormwater Management Plans, where available.

(b) Stormwater detention facilities

Facilities to temporarily store excess storm runoff shall be subject to the following requirements:

(1) Any detention facility whose failure could cause significant damage or loss of life shall be regulated as a dam pursuant to Sections 22a-401 through 22a-409 of the General Statutes.

(2) All detention facilities serving a watershed larger than 10 acres in size shall be analyzed with hydrograph and storage routing techniques.

(3) The release rates from detention facilities shall be consistent with the Basin Stormwater Management Plan for the watershed in which it is located, or comply with items 4, 5 and 6 below if there is no Basin Stormwater Management Plan.

(4) The release rate shall consider the existing and proposed flow rates at the site and downstream channels or structures, and the timing of runoff from other subwatersheds within the basin for the base flood.

(5) The waters released from a detention facility shall not increase the peak flow rate at offsite downstream points unless they have adequate flow capacity for the base flood.

(6) Extended duration detention facility discharges directly into alluvial or eroding channels shall not exceed the bankfull capacity or the 2 year flood frequency flow, whichever is less, unless it is determined said channel will be stable.

(7) Section 8E of the "Connecticut Guidelines for Erosion and Sediment Control" (1985) as may be amended, shall be used as a guide to construction details and materials.

(8) An operation and maintenance schedule shall be prepared for every detention facility identifying responsibilities and items of routine maintenance, after use and emergency operations in the event of a flood.

(c) Storm Drainage Systems.

All subsurface storm drainage systems shall be designed in accordance with the methods and procedures defined in the Connecticut Department of Transportation Drainage Manual prepared by the Division of Design, Bureau of Highway, as may be amended and shall meet the following requirements:

(1) Storm drainage systems for parking lots, driveways, and roads shall be designed for a ten year frequency storm without closing use of the facility.

(2) The design of storm drainage systems for depressed roads and driveways shall comply with the DOT Drainage Manual.

(3) Use of curbing shall be minimized in order to encourage overland disbursed flow through stable vegetated areas.

(4) The hydrology and hydraulic design of catch basins, gutters, and storm drain pipes shall comply with the DOT Drainage Manual.

(5) Design computations shall be prepared on the appropriate forms contained in the DOT Drainage Manual.

(6) The foundation drains and floor drains of buildings connected into storm drainage systems shall be designed to prevent backflow for the 100 year frequency flood into the building.

(7) Surface runoff shall be directed through vegetated filter strips or grass swales wherever possible prior to storm drain inlets.

(8) The design of the storm drainage system should be coordinated with the soil erosion and sediment control plan.

(9) Storm drainage discharges shall be coordinated with the National Pollution Discharge Elimination System permit program administered by the Water Compliance Unit of DEP.

(10) Storm drainage systems discharging into watercourses tributary to public water supply reservoirs shall be in compliance with the Public Health Code.

(11) Storm drains shall be extended to a suitable discharge point into a watercourse or public drainage system, or to where drainage rights have been secured.

(d) Open Channels.

The analysis and design of open channels shall be consistent with the type of channel and its intended purpose. Channels shall be classified as local drain-

age channels or as watercourse channels, depending on use, and shall be classified as alluvial or non-alluvial based upon their geologic characteristics.

(1) Type A open channels are local drainage channels with a primary purpose of conveying urban, parking lot and road runoff from small watersheds, frequently with intermittent flow and limited ecological value and are intended to convey their design flow within their banks. They shall be designed in accordance with Section 12.02, 12.03, and 12.04 of the DOT Drainage Manual and:

(A) Freeboard allowances shall be provided in proportion to the potential damages that could occur in the event of overtopping;

(B) The use of impervious linings is discouraged except for very high velocity flow and steep slopes;

(2) Type B open channels are natural perennial watercourses or man made channels planned to simulate a natural watercourse. They shall be designed in accordance with Section 12.05 of the DOT Drainage Manual and the following where appropriate:

(A) Shall have minimum flow capacity of a flood equal to at least 25 year frequency flood.

(B) Shall have an inner channel to concentrate low flows with a capacity of a 2 year frequency flood.

(C) Shall have water surface profiles prepared for the 2, 25, and 100 year frequency floods.

(D) Shall consider the hydraulic capacity of floodplains.

(E) Shall have a sediment transport capacity similar to upstream and downstream channels.

(F) Shall be designed to minimize the use of artificial linings for flows in excess of the two year frequency flood.

(G) Shall encourage ecological productivity and variety.

(H) Shall be visually compatible with its surroundings.

(I) The alignment and slope shall be compatible with natural channels in similar site conditions.

(J) Variations in width, depth, invert evaluations, and side slopes are encouraged for aquatic and visual diversity.

(K) Straightening channels and decreasing their length is discouraged.

(L) The cross sections used to define the channel and floodplain geometry for water surface profile computations shall be located upstream and downstream of hydraulic structures, at changes in bed slope or cross section shape, and generally at intervals of not more than ten times the width of the 100 year floodplain.

(M) The friction coefficients used in the hydraulic analysis are to assume maximum seasonal vegetation conditions, and should be adjusted to the depth of flow.

(3) Channel restoration plans shall be prepared for all open channel work. The plan shall help restore and/or create an aquatic habitats suitable for fisheries, while maintaining or improving water quality, recreation, aesthetics and flow capacity. Coordination with the Fisheries and Wildlife Units of DEP is recommended. The channel restoration plan shall include, as appropriate:

(A) Avoidance of barriers to fish movement;

(B) Formation of pools and riffles;

(C) Provision for areas of sheltered flow with use of deflectors, boulders, low check dams;

(D) Preservation of stream bank vegetation and establishment of new vegetation;

(E) Use of clean natural bed materials of a suitable size;
(F) Schedule work to minimize conflicts with spawning, stocking, and fishing seasons; and
(G) Removal of excess debris.
(4) The design of rock riprap in channels with uniform flow shall be based upon the tractive force methods defined in both the DOT Drainage Manual and the Connecticut Guidelines for Erosion and Sediment Control.
(5) The hydraulic analysis and modification of watercourses prone to ice jams or floods due to ice should be coordinated directly with the Department of Environmental Protection.
(6) The watersurface profiles of open channels in coastal areas shall consider the potential combined occurrence of tides, storm surges, and peak runoff. The starting water elevation for the base flood in watersheds with time of concentrations of over 6 hours shall be the ten year frequency tidal surge level.
(e) Culverts and Bridges.
All drainage culverts and bridges shall be designed in accordance to the methods and procedures defined in the DOT Drainage Manual and shall meet the following requirements:
(1) Culverts and bridges will be designed for flood frequencies and underclearances stipulated in the DOT Drainage Manual, except that on local (not state highways) roads and driveways with low traffic volumes and where alternate routes are available, lower design criteria is acceptable when:
(A) Flood discharges may be allowed to cross over roads that are at or close to the floodplain grade.
(B) Water surface elevations shall not be increased by more than one foot, nor allowed to cause damage to upstream properties.
(C) Provisions are made to barricade the road when overtopped.
(D) The road or driveway is posted as being subject to flooding.
(2) Bridges and culverts along stocked watercourses and watercourses which may support fish shall be designed to allow passage of fish as may be recommended by the Department of Environmental Protection Fisheries and Wildlife Units.
(3) The location of new bridges and culverts shall minimize the relocation of watercourses.
(4) Where applicable, rigid structural floors at bridges and culverts should be depressed below the normal streambed, to allow an alluvial streambed to form over them, and shall anticipate if the streambed is degrading.
(5) The use of solid parapet walls at bridges and culverts located in the sag part of vertical curves is discouraged.
(6) Debris barriers shall be used upstream of structures prone to blockage by debris.
(7) The use of a single large culvert or bridge opening is preferred over use of multiple small openings.
(8) The underclearances and maximum headwaters stipulated in the DOT Drainage Manual may be waived when decreasing the headwater depth at existing structures could increase downstream peak flows.
(f) Standard Conditions for Approval.
(1) All construction work shall incorporate best management practices to minimize soil erosion and sedimentation and conform with the "Connecticut Guidelines for Soil Erosion and Sediment Control."
(2) All fill shall be clean, material free of stumps, rubbish, hazardous, and toxic material.

(3) Contractor shall remove equipment and materials from the floodplain during periods when flood warnings have been issued or are anticipated by a responsible federal, state or local agency. It shall be the contractors responsibility to obtain such warnings when flooding is anticipated.

(4) Contractor shall notify the Commissioner seven days prior to starting work on-site.

(5) Once work is initiated, it shall proceed rapidly and steadily until completed and stabilized in order to minimize use of temporary structures and to minimize soil erosion.

(6) Work shall not be conducted in or adjacent to watercourses and reservoirs used as public drinking water supply sources without further coordination with the water supply utility and Department of Health Services.

(7) All temporary structures, cofferdams, and fill shall not impede the movement of flood flows and shall be removed at the completion of their use. The design of such temporary structure, cofferdams and fill shall be based on Chapter 18 of the DOT Drainage Manual, where applicable.

(8) The applicant or his agent shall permanently maintain the proposed facility.

(g) **Basin Stormwater Management Plans.**

Basin stormwater management plans shall be prepared at the scale of the subregional drainage basins as defined on the map entitled "Natural Drainage Basins of Connecticut" prepared by the Department of Environmental Protection dated 1981 or as amended. Basin stormwater management plans shall include:

(1) Watershed identification, surficial geology, and land use.

(2) Inventory of flood hazard areas as identified by Flood Insurance Studies or the Commissioner, plus historic floods and damages.

(3) An evaluation of watercourses, including areas of limited flow capacity, bank or bed erosion, sediment deposition, water quality, principle water uses and users, recreation areas, morphology classification, and channel stability.

(4) An inventory and evaluation of hydraulic structures, including culverts, bridges, dams and dikes with information on their flow capacity and physical condition.

(5) An inventory of significant flood water storage areas, including principle impoundments, floodplains, and wetlands.

(6) A runoff hydrograph analysis of the watershed for floods of an appropriate duration, including a 24 hour event, with average return frequencies of 2, 10 and 100 years for existing and future land uses.

(7) The relationship between the computed peak flow rates and gauging station data, with modification or calibration of the hydrographs to obtain a reasonable fit where necessary.

(8) Identification of the peak rate of runoff at various key points in the watershed, and the relative timing of the peak flow rates.

(9) Identification of points in the watershed where hydraulic structures or watercourses are inadequate under existing or anticipated future conditions.

(10) Recommendations on how the subwatersheds runoff can be managed to minimize any harmful downstream impacts.

(11) Generalized recommendations for physical improvements for existing or anticipated future problem areas.

(12) A copy of each Basin Stormwater Management Plan shall be filed with the DEP.

(13) Stormwater management plans for Public Water Supply watersheds shall be coordinated with the Connecticut Department of Health Services and any affected water utility company.

Statement of purpose: These regulations establish standards for stormwater management and flood flows and procedures for certification or exemption of an activity or a critical activity within or affecting the floodplain.

Be it known that the foregoing regulations are adopted as hereinabove stated by the aforesaid agency pursuant to Sec. 25-68h of the General Statutes, after publication in the Connecticut Law Journal on June 24, 1986, of the notice of the proposal to adopt such regulations, and the holding of an advertised public hearing on the 20th day of August, 1986.

Wherefore, the foregoing regulations are hereby adopted, effective when filed with the Secretary of the State.

In Witness Whereof: February 26, 1987, Stanley J. Pac, Commissioner.

Approved by the Attorney General as to legal sufficiency in accordance with Sec. 4-169, as amended, General Statutes: March 2, 1987.

Approved by the Legislative Regulation Review Committee in accordance with Sec. 4-170, as amended, of the General Statutes: April 21, 1987.

Two certified copies received and filed, and one such copy forwarded to the Commission on Official Legal Publications in accordance with Sec. 4-172, as amended, of the General Statutes, Secretary of the State: April 30, 1987.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Oil and Gas Exploration and Production

The Regulations of Connecticut State Agencies are amended by adding Section 22a-472-1 as follows:

Sec. 22a-472-1. Oil and gas exploration and production

(a) Definitions

(1) The definitions of the following terms used in this section shall be the same as the definitions in section 22a-423 of the General Statutes: Commissioner, person and pollution.

(2) For the purposes of this section:

"Blowout Preventer" means equipment installed at the wellhead for the purpose of preventing an uncontrolled flow of gas, oil or other well fluids in the space between the casing and the drill pipe or in an open hole during drilling, completion, or production operations;

"Cement Bond Log" means a record of the type of cement used to fill the annular space about the casing, the injection method used to inject cement into such annular space, the depth to which such cement has been so injected, and the date of such cement injection;

"Cement Plug" means a section of a well filled with cement;

"Electrical Well Log" means the record of electrical characteristics of the geologic horizons intersected by a well;

"Exploration" means activities conducted for the purpose of obtaining geological, geophysical of geochemical information about oil or gas in the State including seismic activities but not including exploratory well drilling or aerial surveys;

"Fresh-Water Bearing Horizon" means any geologic strata or horizon yielding or containing water with less than 10,000 parts per million of total

BIBLIOGRAPHY

Bridgeport, City of. Chapter 19A: Soil Erosion and Sediment Control Regulations. Bridgeport, CT.

Enfield, Town of. Subdivision Regulations. Enfield: Enfield Planning and Zoning Commission, 1992.

Federal Emergency Management Agency (FEMA). Answers to Questions About the National Flood Insurance Program. Washington, DC: FEMA, 1992.

———. Further Advice on Executive Order 11988—Floodplain Management. Washington, DC: FEMA, 1987.

———. National Flood Insurance Program and Related Regulations. Washington, DC: FEMA, 1987.

Griswold, Town of. Inland Wetlands and Watercourses Conservation Commission Regulations. Griswold: Griswold Inland Wetlands and Watercourses Commission, 1993.

———. Road Ordinance. Griswold: Griswold Board of Selectmen, 1989.

———. Subdivision Regulations. Griswold: Griswold Planning and Zoning Commission, 1990.

———. Zoning Regulations. Griswold: Griswold Planning and Zoning Commission, 1992.

Groton, Town of. Road and Drainage Construction Standards. Groton: Groton Planning Commission, 1990.

Litchfield, Town of. Subdivision Regulations. Litchfield, CT: Litchfield Planning and Zoning Commission.

Milford, City of. Engineering Guidelines for Preparation of Site Plans, Plot Plans, and Other Proposed Property Development Plans. Milford, CT: Milford Engineering Bureau, 1991.

Salem, Town of. Design and Construction Standards: Construction and Acceptance of Roads in the Town of Salem, Connecticut. Salem, CT, 1990.

———. Inland Wetlands and Watercourses Regulations. Salem: Inland Wetlands and Conservation Commission, 1992.

———. Zoning Regulations and Subdivision Regulations. Salem: Salem Planning and Zoning Commission, 1992.

Shelton, City of. Subdivision Regulations. Shelton: Shelton Planning and Zoning Commission, 1978.

Stamford, City of. Requirements for Site Plan Submittal to Stamford Engineering Bureau. Stamford, CT, 1989.

Thompson, Town of. Subdivision Regulations. Thompson: Planning and Zoning Commission, 1991.

———. Zoning Regulations. Thompson: Planning and Zoning Commission, 1993.

U.S. Water Resources Council. Floodplain Management Guidelines for Implementing E.O. 11988. Washington, DC: U.S. Water Resources Council, 1978.

Vernon, Town of. Subdivision Regulations. Vernon: Vernon Zoning and Planning Commission.

———. Zoning Regulations. Vernon: Vernon Zoning and Planning Commission.

Waterbury, City of. Land Subdivision Regulations of the City Plan Commission. Waterbury, CT: Waterbury City Plan Commission, 1993.

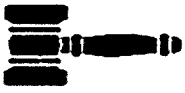
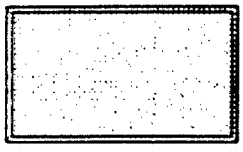
West Hartford, Town of. Zoning: Chapter 177. Rochester, NY: General Code Publishers, 1990.

Windham, Town of. Public Improvement Specifications. Windham, CT.

Windsor, Town of. Construction Guidelines for Public Improvements in Subdivisions. Windsor, CT.

APPENDIX B
STATE OF CONNECTICUT
MODEL FLOOD DAMAGE PREVENTION ORDINANCE

KEY TO CONNECTICUT'S MODEL FLOOD DAMAGE PREVENTION ORDINANCE

TEXT SHOWN AS	*IS*
UNBOXED	REQUIRED
BOLD	REQUIRED BY 1986 AMENDMENTS TO GOVERNING FEDERAL REGULATIONS
	REQUIRED FOR ORDINANCES, RECOMMENDED FOR REGULATIONS
	OPTIONAL TEXT
	RECOMMENDED
	NOT RECOMMENDED (LEAST RESTRICTIVE ALLOWABLE)
	NOTE TO USER

CONNECTICUT'S MODEL
FLOOD DAMAGE PREVENTION ORDINANCE
"D Communities"

REQUIRED FOR ORDINANCES, RECOMMENDED FOR REGULATIONS

SEC. 1 STATUTORY AUTHORIZATION, FINDING OF FACT, PURPOSE AND OBJECTIVES
(OPTIONAL IF YOU PUT STANDARDS IN ZONING REGULATIONS)

1.1 Statutory Authorization

In Section 7-148 (c)(7) of the General Statutes, the Legislature of the State of Connecticut delegates to local governmental units the responsibility of adopting regulations designed to promote the public health, safety, and general welfare of its citizenry. Therefore, the [governing body] of [Name of Community], Connecticut, does ordain as follows:

1.2 Findings of Fact

The flood hazard areas of [Name of Community] are subject to periodic inundation which results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety and general welfare.

These flood losses are caused by the cumulative effect of obstructions in floodplains causing increases in flood heights and velocities, and by the occupancy in flood hazard areas by uses vulnerable to floods or hazardous to other lands which are inadequately elevated, flood-proofed, or otherwise unprotected from flood damages.

1.3 Statement of Purpose. It is the purpose of this ordinance to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

1.3.1 Restrict or prohibit uses which are dangerous to health, safety and property due to water or erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities;

1.3.2 Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;

1.3.3 Control the alteration of natural floodplains, stream channels, and natural protective barriers which are involved in the accommodation of flood waters;

1.3.4 Control filling, grading, dredging and other development which may increase erosion or flood damage; and

1.3.5 Prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands.

RECOMMENDED TEXT

1.4 Objectives. The objectives of this ordinance are:

1.4.1 To protect human life and health;

1.4.2 To minimize expenditure of public money for costly flood control projects;

1.4.3 To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;

1.4.4 To minimize prolonged business interruptions;

1.4.5 To minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets and bridges located in floodplains;

1.4.6 To help maintain a stable tax base by providing for the sound use and development of flood prone areas in such a manner as to minimize flood blight areas; and

1.4.7 To insure that potential home buyers are notified that property is in a flood hazard area.

SEC. 2 DEFINITIONS

Unless specifically defined below, words or phrases used in this ordinance shall be interpreted so as to give them the meaning they have in common usage and to give this ordinance its most reasonable application.

RECOMMENDED TEXT

2.1 "Accessory Structure" means an appurtenant, unfinished structure of less than 401 square feet, the use of which shall be incidental or subordinate to the principal use of the parcel of the principal structure on the parcel.

2.2 "Addition (to an existing building)" means any walled and roofed expansion to the perimeter of a building in which the addition is connected by a common load-bearing wall other than a fire wall. Any walled and roofed addition which is connected by a fire wall or is separated by independent perimeter load-bearing walls is new construction.

2.3 "Appeal" means either (a) a request for a review of the [local administrator]'s decision relative to the provisions of this ordinance or (b) a request for a variance from the requirements of this ordinance.

2.4 "Base flood" means the flood having a one percent chance of being equaled or exceeded in any given year.

RECOMMENDED TEXT

2.5 "Basement" means that portion of a building having its floor subgrade (below ground level) on all sides.

2.6 "Building" means any structure built for support, shelter, or enclosure for any occupancy or storage.

2.7 "Development" means any man-made change to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavating, drilling operations, or permanent storage of materials.

RECOMMENDED TEXT

2.8 "Elevated building" means a non-basement building built to have the lowest floor elevated above the ground level by means of fill, solid foundation perimeter walls, pilings, columns (posts and piers), shear walls, or breakaway walls, as allowed under applicable standards.

2.9 "Flood" or "flooding" means a general and temporary condition of partial or complete inundation of normally dry land areas from:

1. the overflow of inland or tidal water;
2. the unusual and rapid accumulation or runoff of surface waters from any source.

2.10 "Flood Boundary and Floodway Map" means an official map of a community on which the Federal Emergency Management Agency has delineated the boundaries of the floodway.

2.11 "Flood Hazard Boundary Map (FHBM)" means an official map of a community, issued by the Federal Emergency Management Agency, where the boundaries of the special flood hazard areas have been defined as A zones.

2.12 "Flood Insurance Rate Map (FIRM)" means an official map of a community on which the Federal Emergency Management Agency has delineated both the special flood hazard areas and the applicable risk premium zones. FIRMs published after January 1990 may also show the boundaries of the floodway.

2.13 "Flood Insurance Study" is the official report by the Federal Emergency Management Agency. The report contains flood profiles, the water surface elevation of the base flood, and other flood data.

2.14 "Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

2.15 "Floor" means the top surface of an enclosed area in a building (including basement) i.e., top of slab in concrete slab construction or top of wood flooring in wood frame construction. The term does not include the floor of a garage used solely for parking of vehicles.

RECOMMENDED TEXT

2.16 "Functionally Dependent Facility" means a facility which cannot be used for its intended purpose unless it is located in close proximity to water, such as a docking or port facility necessary for the loading and unloading of cargo or passengers, shipbuilding, ship repair, or seafood processing facilities. The term does not include long-term storage, manufacture, sales, or service facilities.

NOTE: Removal of the "habitable floor" definition is required. Removal of all references to "habitable floor" and substitution of the term "lowest floor" is required.

2.17 "Highest Adjacent Grade" means the highest natural elevation of the ground surface, prior to construction, next to the proposed walls of a structure.

2.18 **"Lowest Floor" means the lowest floor of the lowest enclosed area (including basement).** (*CONDITIONAL ADDITION*: The following sentence may be included in the definition of lowest floor ONLY IF the ordinance allows fully-enclosed areas below base flood elevation in accordance with the standards contained in Section 5.3.4 hereof: "An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access or storage, in an area other than a basement area is not considered a building's lowest floor, provided that such an area fully meets the requirements of Section 5.3.4 hereof.")

NOTE: Substitution of the following for the definition of "mobile home" is required. All references to "mobile home" must be changed to "manufactured home". It may be appropriate to include a parenthetical reference to "mobile home" following the term "manufactured home", if this definition matches one in a preceding definitions section.

2.19 **"Manufactured Home" means a structure, transportable in one or more sections, which is built on a permanent chassis and designed to be used with or without a permanent foundation when connected to the required utilities. Recreational vehicles and similar transportable structures placed on a site for 180 consecutive days or longer shall be considered manufactured homes for the purpose of this ordinance.**

NOTE: Substitution of the following for the definition of "existing mobile home park or mobile home subdivision" is required.

RECOMMENDED TEXT

2.20 "Manufactured Home Park or Subdivision" means a parcel, or contiguous parcels, of land divided into two or more manufactured home lots for rent or sale.

2.21 "Mean Sea Level" means, for purposes of the National Flood Insurance Program, the National Geodetic Vertical Datum (NGVD) of 1929 or other datum, to which base flood elevations shown on a community's Flood Insurance Rate Map are referenced.

2.22 "New Construction" means structures for which the "start of construction" commenced on or after [insert the effective date of community's original flood ordinance - NOT the revision date] and includes any subsequent improvements to such structures.

2.23 "Recreational Vehicle" means a vehicle which is (i) built on a single chassis, (ii) 400 square feet or less when measured at the largest horizontal projections; (iii) designed to be self-propelled or permanently towable by a light-duty truck; and (iv) designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel, or seasonal use.

2.24 "Special Flood Hazard Area" is the area within a community subject to one percent or greater chance of flooding in any given year, as identified on the community's FIRM.

NOTE: Substitution of the following for the definition of "start of construction" is required.

2.25 "Start of Construction" (for other than new construction or substantial improvements under the Coastal Barrier Resources Act (P.L. 97-348)), includes substantial improvement, and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, or improvement was within 180 days of the permit date. *(OPTIONAL, CLARIFYING LANGUAGE: Should the permittee fail to commence work within this time frame a new permit shall be required.)* The actual start means the first placement of permanent construction of a structure (including a manufactured home) on a site, such as the pouring of slabs or footings, installation of piles, construction of columns, or any work beyond the stage of excavation or placement of a manufactured home on a foundation. Permanent construction does not include land

preparation, such as clearing, grading and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for a basement, footings, piers or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure.

RECOMMENDED TEXT

2.26 "Structure" means a walled and roofed building that is principally above ground, a **manufactured** home, a gas or liquid storage tank.

2.27 "Substantial Damage" means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

2.28 "Substantial Improvement" means any combination of repairs, re-construction, alteration, or improvements to a structure taking place (*OPTIONAL ADDITION, CHOOSE: during the life of a structure OR over a one (1) year period)*, in which the cumulative cost equals or exceeds fifty percent of the market value of the structure. The market value of the structure should be (1) the appraised value of the structure (*OPTIONAL BUT HIGHLY RECOMMENDED ADDITION, CHOOSE METHOD WHICH BEST FITS TOWN NEEDS: "using the cost approach to value" OR "using the square foot method" OR "using the quantity survey method" OR "using the segregated cost method"*) prior to the start of the initial repair or improvement, or (2) in the case of damage, the value of the structure prior to the damage occurring. For the purposes of this definition, "Substantial Improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. The term does not, however, include any improvement project required to comply with existing health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions.

RECOMMENDED TEXT

2.29 "Variance" is a grant of relief from the requirements of this ordinance which permits construction in a manner otherwise prohibited by this ordinance where specific enforcement would result in unnecessary hardship. Such hardship shall be based on the unusual physical characteristics of the property in question which are not shared by adjacent parcels; hardship shall not be based on the structure, nor on economic or personal hardships.

2.30 "Water Surface Elevation" means the height, in relation to the National Geodetic Vertical Datum (NGVD) of 1929, (or other datum, where specified) of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas.

SEC. 3 GENERAL PROVISIONS

3.1 Lands to Which This Ordinance Applies

This ordinance shall apply to all special flood hazard areas within the jurisdiction of [Name of Community].

3.2 Basis for Establishing the Special Flood Hazard Areas

The special flood hazard areas identified by the Federal Emergency Management Agency in its [flood study or FHBM map], dated _____, with accompanying FIRM and floodway maps and other supporting data, and any revision thereto, are adopted by reference and declared to be a part of this ordinance.

3.3 Establishment of the Floodplain Development Permit

A Development Permit shall be required in conformance with the provisions of this ordinance prior to the commencement of any development activities.

NOTE: The following Section 3.3 may be substituted for the version above. Select whichever suits your local administrative process best.

RECOMMENDED TEXT

3.3 Establishment of the [Floodplain Management] section of the [Development/Building/Zoning] Permit. The applicable sections of the [Development/Building/Zoning] Permit must be completed in conformance with the provisions of this [section/ordinance] prior to the commencement of any development activities.

3.3.1 Permit Expiration. Permits issued under this ordinance shall expire if actual construction of a permitted structure does not commence within 180 days of the permit approval date.

3.4 Compliance

No structure or land shall hereafter be located, extended, converted, modified or structurally altered without full compliance with the terms of this ordinance and other applicable regulations.

3.5 Abrogation and Greater Restrictions

This ordinance is not intended to repeal, abrogate, or impair any existing easements, covenants, or deed restrictions. Where this ordinance and another conflict or overlap, whichever imposes the more stringent restrictions shall prevail.

RECOMMENDED TEXT

3.6 Interpretation

In the interpretation and application of this ordinance all provisions shall be: 1) considered as minimum requirements; 2) liberally construed in favor of the governing body, and; 3) deemed neither to limit nor repeal any other powers granted under state statutes.

3.7 Warning and Disclaimer of Liability

The degree of flood protection required by this ordinance is considered the minimum reasonable for regulatory purposes and is based on scientific and engineering consideration. Larger floods can and will occur on rare occasions. Flood heights may be increased by man-made or natural causes. This ordinance does not imply that land outside the special flood hazard areas or uses permitted within such areas will be free from flooding or flood damages. This ordinance shall not create liability on the part of the [Town/City of] or any officer or employee thereof for any flood damages that result from reliance on this ordinance or any administrative decision lawfully made thereunder.

SEC. 4 ADMINISTRATION

4.1 Designation of Administrator

The [local administrator] is hereby appointed to administer and implement the provisions of this ordinance.

4.2 Certification

Where required under this [section/ordinance], a registered professional engineer or architect shall certify that the design and methods of construction are in accordance with accepted standards of practice for meeting the provisions of this [section/ordinance]. Such certification must be provided to the [local administrator].

NOTE: Whether specified in the ordinance/regulation or not, the following duties and responsibilities are required of the administrator (Sections 4.3 And 4.4).

RECOMMENDED TEXT

4.3 Permit Procedures

Prior to any development activities, application for a [Development/Building/Zoning] Permit shall be made to the [local administrator] on forms furnished by him or her.

RECOMMENDED TEXT

Such application shall be accompanied by two sets of plans drawn to scale showing, at a minimum, the property lines and location of the parcel; existing and proposed contours; existing or proposed structures, fill, storage of materials, drainage facilities and the location of the foregoing. The following information shall also be submitted to the [local administrator].

4.3.1 Application Stage

4.3.1.1 Elevation in relation to mean sea level of the proposed lowest floor (including basement) of all structures (Section 5.3.1 - 5.3.3);

4.3.1.2 Elevation in relation to mean sea level to which any non-residential structure will be flood-proofed (Section 5.3.3.2);

4.3.1.3 Description of the extent to which any watercourse will be altered or relocated as a result of proposed development (Section 5.1.8);

4.3.1.4 A statement as to whether or not the proposed alterations to an existing structure meet the criteria of the substantial improvement definition (Section 2.28);

NOTE: Section 4.3.1.5 exceeds the minimum federal standards.

4.3.1.5 A statement as to whether there will be dry vehicular access to residential structures during the 100-year storm event;

4.3.1.6 Certification as to use of floodproofing for non-residential structures, as required by Section 5.3.3.2;

4.3.1.7 Certification as to the provisions of Section 5.3.4 governing fully-enclosed areas below base flood elevation, if the minimum design criteria in Section 5.3.4.1.1 - 5.3.4.1.3 is not used;

4.3.1.8 Certification of compliance with the floodway standards contained in Sections 5.2.3 and 5.3.5.

4.3.2 Construction Stage

Upon completion of the applicable portion of construction the applicant shall provide the [local administrator] with verification of the as-built lowest floor elevation, defined as the top of the lowest floor (including basement) (Sections 5.3.1 - 5.3.3.1) or, in the case of floodproofed buildings, the elevation to which the floodproofing is effective (Section 5.3.3.2).

RECOMMENDED TEXT

4.3.3 Compliance. Deficiencies in the lowest floor elevations shall be corrected by the permit holder immediately and prior to further progressive work being permitted to proceed. Failure to submit an acceptable survey or failure to make corrections required hereby shall be cause for issuance of a stop-work order.

4.4 Duties and Responsibilities of the [local administrator]

In the administration of this [section/ordinance], the [local administrator] shall perform the following duties, among others:

4.4.1 Application Stage

4.4.1.1 Review all permit applications to determine whether proposed building sites will be reasonably safe from flooding.

4.4.1.2 Review all development permits to assure that the requirements of this ordinance have been satisfied.

4.4.1.3 Advise permittee that additional Federal or State permits may be required, and if specific Federal or State permit requirements are known, require that copies of such permits be provided and maintained on file with the [Development/ Building/Zoning] Permit. Such additional permit requirements may include, but not be limited to: Stream Channel Encroachment Line Permit, Coastal Area Management Permit, Water Diversion Permit, Dam Safety Permit, Corps of Engineers 401 & 404 Permits.

RECOMMENDED TEXT

4.4.1.4 Notify the regional planning agency and the affected municipality at least 35 days prior to the public hearing if any change of regulation or use of a flood zone will affect an area within 500 feet of another municipality.

4.4.1.5 Notify adjacent communities and the Department of Environmental Protection, Inland Water Resources Management Division prior to any alteration or relocation of a watercourse, and submit evidence of such notification to the Federal Emergency Management Agency.

RECOMMENDED TEXT

4.4.1.6 Assure that maintenance is provided within the altered or relocated portion of said watercourse so that the flood-carrying capacity is not diminished.

RECOMMENDED TEXT

4.4.1.8 Make the necessary interpretation, where needed, as to the exact location of boundaries of the special flood hazard areas (for example, where there appears to be a conflict between a mapped boundary and actual field conditions). The person contesting the location of the boundary shall be given a reasonable opportunity to appeal the interpretation as provided in this article.

4.4.1.9 Require the applicant to provide base flood elevation data for all proposed development (including manufactured home parks and subdivisions) which are five acres or fifty lots, which ever occurs first, and are located in Zone A.

4.4.1.10 Obtain, review and reasonably utilize any base flood elevation and floodway data available from a Federal, State or other source(*), including data developed pursuant to Section 4.4.1.9 of this ordinance, in order to administer the provisions of Section 5.3, when base flood elevation data or floodway data have not been provided in accordance with Section 3.2. **(*) (remove any statement to the effect of: "until such data is provided by FEMA")**

4.4.2 Construction Stage

4.4.2.1 Record the as-built elevation (in relation to mean sea level) of the lowest floor (including basement) of all new construction or substantially improved structures, in accordance with Sections 5.3.1 - 5.3.3.1.

4.4.2.2 Record the elevation (in relation to mean sea level) to which the new or substantially improved structures have been flood-proofed, in accordance with Section 5.3.3.2.

4.4.2.3 Maintain all records pertaining to the provisions of this [section/ordinance].

RECOMMENDED TEXT

4.4.2.4 Require that a note be recorded on the land records indicating that the parcel is subject to the 100-year flood.

SEC. 5 PROVISIONS FOR FLOOD HAZARD REDUCTION

5.1 General Standards

In all special flood hazard areas the following provisions shall apply:

5.1.1 New construction and substantial improvements shall be anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy;

5.1.2. New construction and substantial improvements shall be constructed with materials (*) resistant to flood damage;
(* remove "and utility equipment" which has been replaced by new section - 5.1.4)

5.1.3. New construction or substantial improvements shall be constructed by methods and practices that minimize flood damage;

5.1.4 Electrical, heating, ventilation, plumbing, air conditioning equipment, and other service facilities shall be designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

5.1.5 New and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the system;

5.1.6 New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the system into flood waters;

5.1.7 On-site waste disposal systems shall be located and constructed to avoid impairment to them or contamination from them during flooding;

5.1.8 In any portion of a watercourse which is altered or re-located the flood carrying capacity shall be maintained;

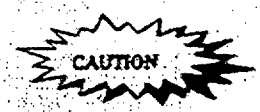
RECOMMENDED TEXT

5.1.9 Accessory Structures. Accessory structures (as defined herein) shall be subject to all the standards of Sections 5.1, 5.2 and all standards of Section 5.3, as applicable. At the discretion of the [local administrator], accessory structures may also be required to meet the standards of Section 5.3.1 through 5.3.5.

5.1.10 Manufactured Homes. *(YOU MUST PICK ONE OF THE FOLLOWING TWO CHOICES OR ANOTHER AS APPROVED BY DEP.)*

RECOMMENDED TEXT

Manufactured homes are prohibited in all special flood hazard areas.



NOT RECOMMENDED (LEAST RESTRICTIVE STANDARD ALLOWABLE)

All manufactured homes (including recreational vehicles placed on a site for 180 consecutive days or longer) to be placed or substantially improved shall be installed using methods and practices which minimize flood damage. They shall also be elevated and anchored to resist flotation, collapse and lateral movement. Methods of anchoring may include, but are not limited to, use of over-the-top or frame ties.

If you do select the non-recommended option, we recommend you append the following language to it:

Elevation construction standards include piling foundations placed no more than 10 feet apart, and the provision of reinforcement for piers more than six feet above ground level. Adequate access and drainage should be provided.

5.2 Standards for Stream Without Established Base Flood Elevations, Floodways and/or Flood Mapping

5.2.1 The [local administrator] shall obtain, review and reasonably utilize any base flood elevation and floodway data available from a Federal, State or other source, including data developed pursuant to [Section 4.4.1.9] or [Section 6.4. of this ordinance OR Section ???? of the Town's Subdivision Regulations], as criteria for requiring that new construction, substantial improvements, or other development in Zone A on the Community's FIRM meet the standards in Section 5.3.

NOTE: The following section requires that applicants in A zones without BFE's develop such data and provide it to the local official, who will use it as the basis for applying the specific standards of Section 5.3. This section is optional and exceeds the federal minimum. We don't recommend it for all towns but it does make sense for some (several have this rqmt already). Evaluate it for your local situation.

CONDITIONALLY RECOMMENDED TEXT

5.2.2 Base flood elevation data shall be provided with (ANY APPLICATION FOR ACTIVITY IN AN A ZONE OR APPLICATIONS FOR NEW CONSTRUCTION AND/OR SUBSTANTIAL IMPROVEMENTS IN A ZONES).

5.2.3 In A zones where base flood elevations have been determined, but before a floodway is designated, no new construction, substantial improvement, or other development (including fill) shall be permitted which will increase base flood elevations more than one (1) foot at any point along the watercourse when all anticipated development is considered cumulatively with the proposed development.

5.2.4 The [local administrator] may request floodway data of an applicant for watercourses without FEMA-published floodways. When such data is provided by an applicant or whenever such data is available from any other source (in response to the City/Town's request or not), the [City/Town] shall adopt a regulatory floodway based on the principle that the floodway must be able to convey the waters of the base flood without increasing the water surface elevation more than one (1) foot at any point along the watercourse.

5.2.5 The [local administrator] shall obtain, review and reasonably utilize any base flood elevation and floodway data available from a Federal, State or other source, as criteria for requiring that new construction, substantial improvements, or other development in any area of potential, demonstrable or historical flooding within the community meet the standards in Section 5.3.

NOTE: In Section 8-2 of the State statutes towns are charged with protecting public health, safety and welfare. The section specifically authorizes zoning commissions ". . . to secure safety from fire, panic, flood and other dangers . . ." Towns interested in extending the regulated floodplain beyond that area published by FEMA to include other flood areas in town are invited to call on Inland Water Resources staff to discuss how to do this.

5.3 Specific Standards

NOTES: The most restrictive option is simply to not allow any building, filling, or alteration of watercourses in the 100-year flood-plain (or 500-year floodplain) and require a setback from the special flood hazard area.

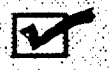
Another measure which protects public safety and property is creating an additional height requirement above the BFE ("freeboard"); one (1) foot freeboard requirements are most common, although we have seen 2' freeboards in some CT towns. The published BFE does not include the extra 0-12 inches of flooding that FEMA would expect to occur if the flood fringe is fully developed as allowed under this program. Requiring elevation only to the published BFE does not provide full protection from the 100-year storm as modeled by FEMA. Additionally, FEMA's model does not factor in changes in the watershed beyond the date of the study. Adding a freeboard requirement can help protect against changes in flood stages which result from additional development; this is especially important for towns with older studies. New development can raise flood heights beyond the "margin of safety" and result in unexpected flooding.

Another recommended measure is to require dry vehicular access to residential structures during the 100-year event.

In all special flood hazard areas A1-30, AE, AH where base flood elevation data has been provided the following provisions shall apply in addition to all the general standards contained in Section 5.1.

5.3.1 Residential Construction. New construction or substantial improvement of any residential structure shall have the lowest floor, including basement, elevated at least to (*OPTIONAL BUT HIGHLY RECOMMENDED ADDITION: "____ feet above"*) the base flood elevation.

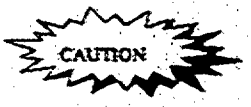
5.3.2 Manufactured Homes. *(THIS SECTION IS REQUIRED UNLESS YOU PROHIBITED MANUFACTURED HOMES IN SECTION 5.1.10 ABOVE. IF YOU DID NOT PROHIBIT THEM YOU MUST PICK ONE OF THE FOLLOWING TWO CHOICES OR ANOTHER AS APPROVED BY DEP.)*



RECOMMENDED TEXT

5.3.2.1 Elevated so that the lowest floor is above the base flood elevation;

5.3.2.2 Placed on a permanent foundation which itself is securely anchored and to which the structure is securely anchored so that it will resist flotation, lateral movement, and hydrostatic and hydrodynamic pressures. Anchoring may include, but not be limited to, the use of over-the-top or frame ties.



NOT RECOMMENDED (LEAST RESTRICTIVE STANDARD ALLOWABLE)

5.3.2.1 Manufactured homes that are placed or substantially improved within Zones A1-30, AH and AE on sites (i) outside of a manufactured home park or subdivision, (ii) in a new manufactured home park or subdivision, (iii) in an expansion to an existing manufactured home park or subdivision, or (iv) in an existing manufactured home park or subdivision on which a manufactured home has incurred "substantial damage" as the result of a flood, shall be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated to or above the base flood elevation and shall be securely anchored to an adequately anchored foundation system to resist floatation, collapse and lateral movement.

5.3.2.2 Manufactured homes that are placed or substantially improved on sites in an existing manufactured home park or subdivision within Zones A1-30, AH, and AE that are not subject to the provisions of Section 5.3.2.1 above shall be elevated so that either (i) the lowest floor of the manufactured home is at or above the base flood elevation, or (ii) the manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above grade and be securely anchored to an adequately anchored foundation system to resist floatation, collapse, and lateral movement.

NOT RECOMMENDED (LEAST RESTRICTIVE STANDARD ALLOWABLE)

5.3.2.3 Recreational vehicles placed on sites within Zones A1-30, AH and AE shall either (i) be on the site for fewer than 180 consecutive days, (ii) be fully licensed and ready for highway use, or (iii) meet all the general standards of Section 5.1 and the elevation and anchoring requirements of Section 5.3.2.1. A recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions.

5.3.3 Non-Residential Construction.

5.3.3.1 New construction or substantial improvement of any commercial, industrial, or non-residential structure located in Zone A1-30, AE & AH shall have the lowest floor, including basement, elevated at least to *(OPTIONAL BUT HIGHLY RECOMMENDED ADDITION: "____ feet above the level of")* the base flood elevation; or

NOTE: If you choose to allow floodproofing by including the following section, you must include Sections 4.3.1.2, 4.3.1.6 and 4.4.2.2.)

NOTE: A one-foot freeboard above BFE is recommended because floodproofing is not recognized and credited in the flood insurance rating process unless it is effective to one foot above BFE.

RECOMMENDED TEXT

5.3.3.2 Non-residential structures located in all A zones may be flood-proofed in lieu of being elevated provided that together with all attendant utilities and sanitary facilities the areas of the structure below the required elevation are water tight with walls substantially impermeable to the passage of water, and use structural components having the capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy. A registered professional engineer or architect shall **review and/or develop structural design specifications and plans for the construction, and shall certify that the design and methods of construction are in accordance with acceptable standards of practice for meeting the provisions of this subsection. Such certification shall be provided to the [local administrator].**

NOTE: The following section is optional and difficult to enforce. Some cautious communities have omitted this from their ordinance/regulations and are allowing these fully-enclosed areas as an "acceptable" variance with appropriate conditions only where reasonable use is an issue. If you do include Section 5.3.4 you must do so in its entirety and you must also include Section 4.3.1.7 and the second sentence in the "lowest floor" definition of 2.18.

NOT RECOMMENDED (LEAST RESTRICTIVE STANDARD ALLOWABLE)

5.3.4 Fully-Enclosed Areas Below Base Flood Elevation. New construction or substantial improvements of buildings that include fully-enclosed areas formed by foundation and other exterior walls below the base flood elevation shall have at least one side at or above grade and shall be designed to preclude finished living space and designed to allow for the automatic entry and exit of flood waters to equalize hydrostatic flood forces on exterior walls.

5.3.4.1 Designs for complying with this requirement must either be certified by a professional engineer or architect or meet the following minimum criteria:

5.3.4.1.1 Provide a minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding;

5.3.4.1.2 The bottom of all openings shall be no higher than one foot above grade; and

5.3.4.1.3 Openings may be equipped with screens, louvers, valves or other coverings or devices provided they permit the automatic flow of floodwaters in both directions. Other coverings must be designed and certified by an engineer or approved by the [local administrator].

5.3.4.2 Electrical, plumbing, and other utilities are prohibited below the base flood elevation; and

5.3.4.3 Use of the enclosed area shall be the minimum necessary to allow for parking of vehicles or limited storage of maintenance equipment used in connection with the premises or entry to the living area (via stairway or elevator).

5.3.5 Floodways. Located within special flood hazard areas established in Section 3.2 are areas designated as floodways. Since the floodway is an extremely hazardous area due to the velocity of flood waters which carry debris and potential projectiles and have erosion potential, no encroachments, including fill, new construction, substantial improvements and other developments shall be permitted unless certification (with supporting technical data) by a registered professional engineer is provided demonstrating that encroachments shall not result in any (0.00 feet) increase in flood levels during occurrence of the base flood discharge. Fences located in the floodway must be aligned with the flow and be of an open design.

5.3.5.1 A permit may be given which allows encroachments resulting in increases in base flood elevations provided the community first obtains a conditional floodway revision by meeting the requirements of C.F.R. 44, Chapter 1, Subsection 65.12.

NOTE: Prohibition on placement of manufactured homes in floodways may be removed.

REQUIRED FOR ORDINANCES, RECOMMENDED FOR REGULATIONS

SEC. 6 STANDARDS FOR SUBDIVISION PROPOSALS

(IF YOU PUT STANDARDS IN YOUR ZONING REGULATIONS PUT THESE STANDARDS OF SECTION 6 IN YOUR SUBDIVISION REGS)

In all special flood hazard areas the following requirements shall apply:

6.1 All subdivision proposals shall be consistent with the need to minimize flood damage;

6.2 All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize flood damage;

6.3 All subdivision proposals shall provide adequate drainage to reduce exposure to flood hazards; and

6.4 Base flood elevation data shall be provided for all subdivision proposals and other proposed development (including manufactured home parks and subdivisions) which are five acres or fifty lots, which ever occurs first, and are located in Zone A.

SEC. 7 VARIANCE PROCEDURES

7.1 The [Appeal Board] as established by [local unit] shall hear and decide appeals and requests for variances from the requirements of this ordinance.

NOTE: Per State statute, the Zoning Board of Appeals must be named the Appeals Board if the flood standards are made a part of the community's zoning regulations.

RECOMMENDED TEXT

7.2 The [Appeal Board] shall hear and decide appeals when it is alleged there is an error in any requirement, decision, or determination made by the [local administrator] in the enforcement or administration of this ordinance.

7.3 Any person aggrieved by the decision of the [Appeal Board] or any person owning land which abuts or is within a radius of one hundred feet (100) of the land in question may appeal within 15 days after such decision to the State Superior Court of [Judicial District], as provided in Section 8-8 of the General Statutes of Connecticut.

RECOMMENDED TEXT

7.4 Specific Situation Variances

7.4.1 Buildings on an Historic Register

Variances may be issued for the reconstruction, rehabilitation or restoration of structures listed on the National Register of Historic Places or the State Inventory of Historic Places without regard to the procedures set forth in the remainder of this section, and provided the proposed reconstruction, rehabilitation, or restoration will not result in the structure losing its historical designation.

NOTE: Buildings on the National or State Historic Register or located in a locally- established historical district are automatically exempt from the minimum regulations of the NFIP. Since CT is a historically water-based state, many of the historical buildings are in flood-prone areas. It is within the purview of the legislative body or local historical district commission to adopt amendments to the historical district ordinance without public meeting so long as they do not alter the district boundaries. If the legislative body acts on its own the historical commission must be allowed to make comments and/or recommendations within 65 days (C.G.S. Sect. 7-147c(c)). Buildings on a register or in a district may not be altered or renovated in any way which would not maintain the historical character of the exterior of the structure. To enhance achievement of the simultaneous goals of good historical preservation and good floodplain management, the community may choose to add the following language to its historical district ordinance or regulation:

> *"NO RENOVATIONS OR ALTERATIONS MAY BE MADE TO AN HISTORICAL STRUCTURE WITHOUT DUE CONSIDERATION AND EFFORT TO INCORPORATE DESIGN CONCEPTS WHICH, WHILE PRESERVING THE HISTORICAL CHARACTER OF THE BUILDING, WILL ALSO SERVE TO REDUCE THE POTENTIAL FOR FUTURE FLOOD DAMAGE AND THREAT TO HUMAN LIFE AND PROPERTY."*

7.4.2 Pre-Existing, Small Lot Location

Variances may be issued by a community for new construction and substantial improvements to be erected on a lot of one-half acre or less in size which is contiguous to and surrounded by lots with existing structures constructed below the base flood level, in conformance with Section 7.6.1 - 7.6.4.

7.4.3 Functionally-Dependent Uses

Variances may be issued for new construction and substantial improvement and other development necessary for the conduct of a functionally dependent use provided the structure or other development is protected by methods that minimize flood damage, creates no additional threat to public safety and meets the requirements of Section 7.6.1 - 7.6.4.

7.4.4 Floodway Prohibition

Variances shall not be issued within any designated floodway if any increase in flood levels during the base flood discharge would result.

☑ ***RECOMMENDED TEXT***

7.5 CONSIDERATIONS FOR GRANTING OF VARIANCES

In passing upon such applications, the [Appeal Board] shall consider all technical evaluations, all relevant factors, all standards specified in other sections of this ordinance and the items listed below as 7.5.1 - 7.5.11. Upon consideration of these factors and the purposes of this ordinance the [Appeal Board] may attach such conditions to the granting of variances as it deems necessary to further the purposes of this ordinance.

7.5.1 The danger that materials may be swept onto other lands to the injury of others;

7.5.2 The danger to life and property due to flooding or erosion damage;

7.5.3 The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner;

7.5.4 The importance of the services provided by the proposed facility to the community;

7.5.5 The necessity of the facility to waterfront location, in the case of a functionally dependent facility;

7.5.6 The availability of alternative locations which are not subject to flooding or erosion damage for the proposed use;

7.5.7 The compatibility of the proposed use with existing and anticipated development;

7.5.8 The relationship of the proposed use to the comprehensive plan and floodplain management program for that area;

7.5.9 The safety of access to the property in times of flood for ordinary and emergency vehicles;

7.5.10 The expected heights, velocity, duration, rate of rise and sediment transport of the flood waters and the effects of wave action, if applicable, expected at the site; and

7.5.11 The costs of providing governmental services during and after flood conditions including maintenance and repair of public utilities and facilities such as sewer, gas, electrical and water systems, and streets and bridges.

7.6 CRITERIA FOR VARIANCES

7.6.1 Variances shall only be issued upon a determination that the variance is the minimum necessary, considering the flood hazard, to afford relief; and in the instance of a historical building, a determination that the variance is the minimum necessary as not to destroy the historic character and result in the loss of historic designation of the building;

7.6.2 Variances may only be issued upon (i) a showing of good and sufficient cause, (ii) a determination that failure to grant the variance would result in exceptional hardship, and; (iii) a determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisance, cause fraud on or victimization of the public, or conflict with existing local laws or ordinances. Only hardships which are based on unusual physical characteristics of the property in question, characteristics which are not shared by adjacent parcels, shall qualify to meet subsection (ii) above. Claims of hardship based on the structure, on economic or on personal circumstances are not sufficient cause for the granting of a variance under this ordinance.

7.6.3 Any applicant to whom a variance is granted shall be given written notice specifying the difference between the base flood elevation and the elevation to which the structure is to be built and stating that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced lowest floor elevation up to amounts as high as $25 for $100 of insurance coverage.

7.6.4 The [local administrator] shall maintain the records of all appeal actions and report any variances to the Federal Emergency Management Agency upon request.

REQUIRED FOR ORDINANCES, RECOMMENDED FOR REGULATIONS

SEC. 8 PENALTIES FOR VIOLATION

Violation of the provisions of this ordinance or failure to comply with any of its requirements, including violation of conditions and safeguards established in connection with grants of variance or special exceptions, shall constitute a misdemeanor. Any person who violates this ordinance or fails to comply with any of its requirements shall, upon conviction thereof, be fined not more than $250.00 per day if proven done willfully and $100.00 per day if not, or imprisoned for not more than 10 days for each day of violation,or both, and in addition, shall pay all costs and reasonable legal fees involved in the case. Nothing herein contained shall prevent the [Town/City of] from taking such other lawful action as is necessary to prevent or remedy any violation.

REQUIRED FOR ORDINANCES

Adopted on _____.

By: _____

_____

_____

_____

_____

(Signatures of Governing Board)

Certified By: _____

Date: _____

APPENDIX C
COMPLETED SURVEY FORMS

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community ENFIELD

2. Office(s) Contacted ENGINEERING JEFFREY S. BURD TOWN ENGINEER

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs PUBLIC WORKS / ENGINEERING

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes ✓ No ____

   for all open channels? Yes ✓ No ____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   bridge RIVERINE ✓
   culvert ✓
   pipe ✓
   retention ponds ✓
   reservoirs ____

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? 25 YR IN ROADS, 50 YR CROSS CULVERTS

7. What design requirement is required for a structure in terms of allowable increases in backwater? BACKWATER STUDY - USING KNOWN FLOOD LEVELS WHEN KNOWN

8. ~~How does the community determine expected or design~~ runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others...)? TR-20 USE TR55

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify correctness of its designs?

0

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	✓
toe of slope channels	✓	dissipators	____
outlet channels	✓		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? NONE

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ✓

14. Does the community include freeboard in the design of its open channel structures?

Yes ____ No ✓ 100 YR OVERFLOW

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? RATIONAL

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes ✓ No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____ GUTTER FLOW ANALYSIS

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____

If yes, what are they? MAX. 300 FEET APART

GUTTER FLOW ANALYSIS 10→25 YR

15" MIN. SIZE

CONCRETE / ACCMP

General

19. What types of controls ~~does the community~~ use to control erosion and sedimentation (e.g. ~~sedimentation~~ dikes and pools, traps, soil ~~stabilizers, slope analysis, chemical binders~~)? HOODS

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

    Yes ✓ No ____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? NO

22. Has the community had any particular proolems with any of the drainage structures mentioned above?

    Yes ✓ No ____ SPOTTED Detention BASIN MAINT.

    If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community Town of Vernon

2. Office(s) Contacted Engineering Dept and Planning Dept.

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Eng. Department

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes ✓ No ____

   for all open channels? Yes ✓ No ____ Also HEC circulars

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   bridge 0
   culvert 1
   pipe 1 Drainage syster - Lots of replacement of rotted CMP
   retention ponds 0
   reservoirs 0

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Flood frequency

7. What design requirement is required for a structure in terms of allowable increases in backwater? None

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)?
   TR 55 and Rational Method

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

    None - needs a rain guage

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	0	swales	maintenance only
toe of slope channels	0	dissipators	0
outlet channels	0		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? HEC circular state Drainage manual

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ✓ No ____ HEC 2

14. Does the community include freeboard in the design of its open channel structures?

Yes ✓ No ____

If yes, what is it? 1' min prefer 2'

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Town uses Rational and TR55 and TR20 developers can use what they want

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?
drain. basin
Yes ✓ No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____

If yes, what are they?

Catch basin spacing by gutter flow analysis.

Pipe size by DOT stormwater analysis

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)?
Developers to use Sediment and Erosion Control Guidelines of State

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No ✓ likes to use infiltration basins in commercial parking lots but they aren't reviewed.

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?
None

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ✓ No ____ Drywells clogging

If yes, give an example and any attempts to rectify the problem.

2X Note: Form was completed by Jeff Oakes of NAI based on notes taken at interview. Town had not completed form.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community TOWN OF GROTON

2. Office(s) Contacted PUBLIC WORKS

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs PUBLIC WORKS

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986), for all drainage structures (bridges, culverts, pipes)? Yes ✓ No ____

   for all open channels? Yes ✓ No ____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

✓ bridge	0	Thames Road
culvert	3	Fishtown Brook Rd.
pipe - ft or miles		
retention ponds	0	
reservoirs	0	

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? FLOOD FREQUENCY (25, 50, & 100 year)

7. What design requirement is required for a structure in terms of allowable increases in backwater? NO FLOODING OF ~~EXISTING~~ ROADS AND BUILDINGS

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)?
   RATIONAL METHOD AND SOIL CONSERVATION SERVICE (TR-55 & TR-20)

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	✓	swales	✓
toe of slope channels	NO	dissipators	✓
outlet channels	✓		

National Eng. Handbook

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)?
Connecticut Guidelines for Soil Erosion and Sediment Control

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ✓

14. Does the community include freeboard in the design of its open channel structures?

Yes ✓ No ____

If yes, what is it? 1.0 FEET

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? RATIONAL METHOD, SOIL CONSERVATION SERVICE TR-20 & TR-55.

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes ✓ No ____ DRAINAGE BASIN (LOCAL)

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____ 25, 50, or 100 YEAR

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____

If yes, what are they?

15" inch minimum pipe size
MAX. CATCH BASIN SPACING IS 350 feet
CATCH BASIN STRUCTURES CONFORM TO CONNECTICUT D.O.T. SPECIFICATIONS

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Sedimentation fence, hay bale dikes, jute netting on steep slopes and ~~them~~ swales

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

    Yes ✓ No ~~✓~~ Thomas Road box culvert

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

22. Has the community had any particular problems with any of the drainage structures mentioned above?

    Yes ____ No ✓

    If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community Salem

2. Office(s) Contacted Town Engineer, Town Selectmen, Planning Commission

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Town Selectmen

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986), ✓

for all drainage structures (bridges, culverts, pipes)? Yes____ No____

for all open channels? Yes ✓ No____ Form 814, 1988 and Para Eng.

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge 1 Sub D Para Eng, approved by State
culvert ✓ DOT 2 years ago
pipe ✓ Replacement only
retention ponds ____
reservoirs ____

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)?

7. What design requirement is required for a structure in terms of allowable increases in backwater? No

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Town Eng.

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs? Non

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	____
toe of slope channels	____	dissipators	____
outlet channels	____		

None

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? Town Eng.

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ____

14. Does the community include freeboard in the design of its open channel structures?

Yes ____ No ____

If yes, what is it?

Stormwater Systems See Road Ordinance.

15. What method of analysis is used by the community to determine design flows for stormwater collection?

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes ____ No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ____ No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ____ No ____

If yes, what are they?

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? See Zoning/Subdiv

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

    Yes _____ No ✓

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

22. Has the community had any particular problems with any of the drainage structures mentioned above?

    Yes _____ No _____

    If yes, give an example and any attempts to rectify the problem.

Note. Most all questions, see Road Ordinance, P/2 Reg, C/C Reg. or see Pond Eng.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community City of Shelton

2. Office(s) Contacted Office of city Engineer

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs City Engineer

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes ✓ No ____

   for all open channels? Yes ✓ No ____ also looks @ designs on individual basis

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	3	1@ 21 sq mile drainage basin but had Fed review 1@ 18.4 sq mile drainage basin
culvert	2	
pipe	Too	numerous to count
retention ponds	0	
reservoirs	0	

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? 100 yr storm in flood plain 25 yr storm in rural areas
   50 yr in residential or commercial subdivision

7. What design requirement is required for a structure in terms of allowable increases in backwater? 0 in flood plain
   otherwise on individual basis

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)?
   Rational Method, TR 20, TR 55 HEC-1

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

    None

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	0	swales	0
toe of slope channels	0	dissipators	0
outlet channels	0		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)?

None - no open channel design

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ✓ would use HEC-2 if open channel were to be designed

14. Does the community include freeboard in the design of its open channel structures?

Yes ✓ No ____ would depend on impact of overtopping

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational Method TR20 TR55

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes ✓ drainage basin No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____ storm frequency although regs say rainfall intensity

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____ 15" minimum diam

If yes, what are they?

CB spacing 400' for ≤ 5% grade
300' for ≥ 5% grade

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? sedimentation ponds, silt fence hay bales CT Guidelines for Sed. and Erosion control Guidelines

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No ✓

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

22. Has the community had any particular problems with any of the drainage structures mentioned above? None

Yes ✓ No ____

If yes, give an example and any attempts to rectify the problem.

Poor maintenance of a detention basin

City planning to look at more frequent storms for design. ie 2-100 yr. rather than past practice of looking only at 50 yr and 100 yr. storms.

* Note: Form completed by Jeff Oakes of NAI from notes taken at interview. City did not complete form.

all same { Department of PW, Highway, Selectmen

BRIDGE OPENING, CULVERT, AND STORMWATER DESIGN STANDARDS AND PRACTICES SAMPLE SURVEY

1. Name of Community Griswold
2. Office(s) Contacted First Selectmen Donald Burdick
3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Elmer Rose Road Foreman, selectmen
4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986), for all drainage structures (bridges, culverts, pipes)? Yes ____ No ____ Doesn't have it

   for open channels? Yes ____ No ____ But uses DOT 86 Standards & Specs

   Drainage Structures — check on this — No Town detailed other subdivision regs or Inland wetland regs

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   - State did new bridge on Bozrah and Skelton Road
   - Town hasn't cut any new roads
   - upgrade some and pipes - replacement of undersized or broken - or due to road widening

bridge	0
culvert	X — replacement
pipe	0
retention ponds	0
reservoirs	0

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Use standard 18" pipe aluminum corrugated cross culverts Figured it will never have a back up
7. What design requirement is required for a structure in terms of allowable increases in backwater? None designed for
8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? None other than experience using 18" and one other case when it wasn't built spec'd 5'-6' d. to put brook under road, but it wasn't built and existing box culvert remains
9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

COE regulates streams with gages

Town doesn't use them

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	0	swales	3
toe of slope channels	0	dissipators	0
outlet channels	1		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? No particular book but rely on experience using stone rip rap.

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No X

14. Does the community include freeboard in the design of its open channel structures?

Yes X No ____

If yes, what is it? field judgement

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Whatever is reqd by subdivision and formerly used → see notes.

16. Is stormwater analyzed on a drainage basin basis or just at the structural level? look subdivision regs

Yes ____ No X

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ____ No ✓ est based on pipe size and experience

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes X No ____

If yes, what are they?

18" ~~15"~~ for average pipe diam.
other when nessary

200' average spacing CB's

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Inland wetland Regs Rip rap outfall and grass and

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)? Inland wetland Commission for erosion control and maybe Pipe sizing though it may be outside their jurisdiction

Yes X No ____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? Subdivision

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes X No ____

If yes, give an example and any attempts to rectify the problem.

Haven't had anything of concern other than as noted following:

NOTE: QUESTIONNAIRE COMPLETED BY JEFF OAKES PE NORMANDEAU ASSOCIATES DURING INTERVIEW WITH ELMER ROSE 6/17/93

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community Thompson

2. Office(s) Contacted Dept of Public Works

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Dept of Public Works

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986), ~~YES~~ NO

   for all drainage structures (bridges, culverts, pipes)? Yes____ No____

   for all open channels? Yes— No____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   bridge 3
   culvert 1
   pipe 2 miles
   retention ponds 0
   reservoirs 0 privately owned water company Crystal Water Co.

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? most use 100 yr. Town rule of thumb is 15" DPW dir

7. What design requirement is required for a structure in terms of allowable increases in backwater? no backwater is designed for other than COE control of dams

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? leave to outside engineer

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

Not done unless there is problem and in 8 yrs there hasn't been any. Main River is controlled by COE (French River West Thompson Dam)

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels No
toe of slope channels No
outlet channels Yes
swales ✓ ~~cat~~ designed per Inland Wetlands
dissipators No

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? Hire outside
outside engr. or State stnds. For 8-14

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes 100 yr flood No ____

14. Does the community include freeboard in the design of its open channel structures?

Yes ____ No ____

If yes, what is it? Depends on engineer

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection?
Subdivision Regs dictate - outside engineers comply w/ regs

see Reg 16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes ____ No ____ see regs

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____ 100 yr

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ____ No ____ See regs or outside engineer

If yes, what are they?

otherwise use existing size if doing replacement

Had used 6" pipe ~~when~~ 8 years ago in a drainage system that is going to be replaced with 15" due to 1 or 2 new catch basins going in upgradient - Not going outside

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? – Inland wetland regs dictate erosion control

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No X use Conn DOT standard -

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? see driveway ordinance

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ____ No ____ see pasture discussion

If yes, give an example and any attempts to rectify the problem.

Northeast Regional planning coming up with driveway culvert design

SCS is working on plan to get State funding to rectify problem

† FORM COMPLETED BY JEFF OAKES PE, DURING INTERVIEW WITH M. VIENS NORMANDEAU ASSOCIATES · 6/17/93

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community CITY OF MIDDLETOWN

2. Office(s) Contacted Public Works Dept. (PWD)

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs PWD

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes ✓ No____

   for all open channels? Yes____ No____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   bridge 0
   culvert 0
   pipe Yes- Minimal - 1000'/job
   retention ponds One
   reservoirs NONE

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Street Drainage 10 year · Culverts 50 year

7. What design requirement is required for a structure in terms of allowable increases in backwater?

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Rational Method - small

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

    1' H.

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	0	swales	0
toe of slope channels	0	dissipators	0
outlet channels	Yes		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)?

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ✓ No ____

14. Does the community include freeboard in the design of its open channel structures?

Yes ✓ No ____

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational Method

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes X No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____

If yes, what are they?

12" Minimum
C.B. Std- DOT
Spacing - 175- 200 Ft

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)?

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ✓ No _____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? Consultants Rational Formula, etc, HEC II for Calculations

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes _____ No ✓

If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community Windsor

2. Office(s) Contacted Public Lands, Roads & Facilities

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Drainage Team

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes X No____

   for all open channels? Yes X No____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   bridge ____
   culvert X
   pipe X
   retention ponds X
   reservoirs ____

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? By size

7. What design requirement is required for a structure in terms of allowable increases in backwater? None, by exception

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Depends on size of watershed.

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs? Visual to none.

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	X
toe of slope channels	X	dissipators	____
outlet channels	X	detention basin	X

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? all of above

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes X No ____

14. Does the community include freeboard in the design of its open channel structures?

Yes ____ No X

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? SCS, rational methods, gutter flow analysis

16. Is stormwater analyzed on a drainage basin basis or just at the structural level? Usually drainage basin

Yes ____ No X on subdivision basis

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes X No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes X No ____

If yes, what are they? Pipe min. 15"/catch basin standard/max. 300 feet between catch basin

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? All types, depends on the construction activity and location.
20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

    Yes _X_ No _____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? Usually D.O.T.

22. Has the community had any particular problems with any of the drainage structures mentioned above?

    Yes _X_ No _____

    If yes, give an example and any attempts to rectify the problem.

    On early designs of drywells, the system had a tendency to silt in. Today, we use a filter fabric on the exterior of the stone filtration system. This prevents fine migration.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community City of New Haven

2. Office(s) Contacted Engineering Department

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Engineering Department

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes ✓ No ____

   for all open channels? Yes ✓ No ____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   bridge 15
   culvert 1
   pipe Too Numerous to Count
   retention ponds 2
   reservoirs 0

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Storm frequency

7. What design requirement is required for a structure in terms of allowable increases in backwater? none no deliberate increase allowed

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)?

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ✓ No ____ where available

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

None

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects). No open channel design done by city

top of slope channels	0	swales	0
toe of slope channels	0	dissipators	0
outlet channels	0		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? none

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ____ none

14. Does the community include freeboard in the design of its open channel structures? none

Yes ____ No ____

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational

16. Is stormwater analyzed on a drainage basin basis or just at the structural level? Drainage basin 1"=40' scale plans available

Yes ✓ No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ____ No ____ Both size of event and cfs

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____

If yes, what are they? 15" min pipe size

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? silt fence, haybales, crushed stone strip between construction site and paved road - use CT DOT manual

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No ✓ - however designs of specific Jobs have been reviewed by DEP

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

None

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ✓ No ____ catch basin clean out

If yes, give an example and any attempts to rectify the problem.

Note: Form was completed by NAI based on notes taken at interview. Town had not completed form.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community CITY OF HARTFORD

2. Office(s) Contacted DEPARTMENT OF PUBLIC WORKS

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs ENGINEERING SVCS.

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

for all drainage structures (bridges, culverts, pipes)? Yes X No ____

for all open channels? Yes X No ____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	____	
culvert	____	
pipe	X	Riverine
retention ponds	____	
reservoirs	____	

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Classified by storm discharge size (usually 10 years).

7. What design requirement is required for a structure in terms of allowable increases in backwater? ~~Designs include backwater preventers.~~ $N' - 1.5 * \Delta i_A$

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Rational Method of Design.

HEC 1

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs? Seldom used.

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	____
toe of slope channels	____	dissipators	____
outlet channels	____	None designed within last 15 years.	

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? N/A

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No _X_

14. Does the community include freeboard in the design of its open channel structures?

Yes _X_ No ____

If yes, what is it? one (1) foot

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational Method.

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes _X_ No ____ INLET control @ CB's ?

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes _X_ No X

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes _X_ No ____

If yes, what are they?

Catch basins (3' X 4') connected by 15" minimum diameter pipes, spaced at 200' to 300' maximum intervals.

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? sumps and traps, silt fences; hay bales.

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes X No ____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?
No standard established.

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ____ No X

If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community City of Stamford

2. Office(s) Contacted Public Works Department

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Engineering Bureau

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

a for all drainage structures (bridges, culverts, pipes)? Yes____ No X

b for all open channels? Yes____ No X

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	X	* Pulaski Street Bridge (State funded,replacing an existing one)
culvert	X	*Fieldstone Road Subdivision (Stonegate): 29 Acres
pipe	X	*Haig Avenue Subdivision (Laurelwood): 20 Acres
retention ponds	X	*Deer Meadow Lane Subdivision: 31 Acres
reservoirs	____	*Other Subdivisions of about same size of watershed

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? By types. Design storm for structures: Bridges: 100-yr. Major culverts: 50-yr. Storm drains: 10 or 25 yr.

7. What design requirement is required for a structure in terms of allowable increases in backwater? In floodway: No increase
In fringes: 0.1 foot increase

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Rational or SCS

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs? Where available (not often)

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	X
toe of slope channels	____	dissipators	____
outlet channels	____		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? Manning and HEC-2

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes X No ____

14. Does the community include freeboard in the design of its open channel structures?

Yes X No ____

If yes, what is it? One foot from HW to TOB

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational, TR 20, TR 55

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

(Drainage basin)

Yes X No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes X No X

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes X No ____

If yes, what are they?

Storm drains: ≥ 15" I.D.
Laterals: 12" I.D.
Catch basins: 4'x2.5'

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Erosion control: Rip-Rap

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes X No ____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?
(see attachment)

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes X No ____

If yes, give an example and any attempts to rectify the problem.

West Lane culvert is overtopped by 5-yr storm. Design was made to open it up. E.P.B. approval is delayed due to opposition of a downstream landowner.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community City of Milford

2. Office(s) Contacted Engineering Bureau of Department of Public Works

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs same as above

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes____ No ✓

   for all open channels? Yes____ No ✓

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	0	knowledge only back to 1980
culvert	0	
pipe	0	
retention ponds	0	
reservoirs	0	

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Storm frequency

7. What design requirement is required for a structure in terms of allowable increases in backwater? None

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Rational Method

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs? None

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

None designed by city

top of slope channels	____	swales	____
toe of slope channels	____	dissipators	____
outlet channels	____		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? likely to go outside for HEC-2 analysis

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ✓ likely to be requested of developers

14. Does the community include freeboard in the design of its open channel structures?

Yes ✓ No ____

If yes, what is it? 1' minimum

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational method

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

drainage basin

Yes ✓ No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____ 10 yr storm for streets
25 yr culverts & bridges

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____ 15" min pipe diam

If yes, what are they?

catch basins 300' min spacing

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Established by Inland Wetland Commission and CT Erosion and Sed. Control Guidelines

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No ✓

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

22. Has the community had any particular problems with any of the drainage structures mentioned above? None

Yes ____ No ✓

If yes, give an example and any attempts to rectify the problem.

* Note: Form was completed by Jeff Oakes of NAI based on notes taken during interview. City had not completed form.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community West Hartford, CT.

2. Office(s) Contacted Community Services - Engineering

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Community Service - Eng.

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986), ✓

for all drainage structures (bridges, culverts, pipes)? Yes ✓ No ____

for all open channels? Yes ✓ No ____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment. 79

bridge ____
culvert ✓
pipe ✓
retention ponds ____ - PRIVATE
reservoirs ____ REGIONAL GOVERNMENT -

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? ALL.

7. What design requirement is required for a structure in terms of allowable increases in backwater? Preferably 1 foot freeboard - no backwater IMPACT ON ADJACENT PROPERTY -

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? SCS - FEMA STUDIES,

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs? Does not - IS NOT UNIFORMLY RECORDED. NO MONITORING DEVICES

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	____
toe of slope channels	____	dissipators	____
outlet channels	____		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? FEMA - Flood Study - SCS HAND BOOK.

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ✓ No ____

14. Does the community include freeboard in the design of its open channel structures?

Yes ✓ No ____ NOT IN REGULATIONS -

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? RATIONAL

16. Is stormwater analyzed on a drainage basin basis or just at the structural level? By Drainage Basin

Yes ____ No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ____ No ✓

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes ✓ No ____

If yes, what are they?

15" Dia desirable minimum
350' - spacing for catch basins
w/ the same simplified same
basin basis

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Hay Bales, S. Fence

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

    Yes ✓ No ____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

22. Has the community had any particular problems with any of the drainage structures mentioned above?

    Yes ____ No ____

    If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community City of Bristol

2. Office(s) Contacted _____

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs City Engr.

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes____ No +

   for all open channels? Yes____ No X

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

   bridge ✓ A Riverine Tidal
   culvert ✓ B Riverine Tidal
   pipe ✓
   retention ponds Private
   reservoirs ____

   Most 13Dc

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Bridge - 100 year

7. What design requirement is required for a structure in terms of allowable increases in backwater? Bridge - 0

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)?

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	_____	swales	_____
toe of slope channels	_____	dissipators	_____
outlet channels	_____		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)?

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes + No _____

14. Does the community include freeboard in the design of its open channel structures?

Yes + No _____

If yes, what is it? 3 ft

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection?

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes _____ No _____ ?

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes + No _____

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes + No _____

If yes, what are they?

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)?

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No X

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ____ No X

If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community CITY OF MERIDEN

2. Office(s) Contacted DEPT. OF PUBLIC WORKS / ENGINEERING BUREAU

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Same as above.

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes____ No X, except grate inlet capacities

   for all open channels? Yes____ No X

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	____	
culvert	✓	140 ac.± , riverine
pipe	✓	60 ac.± , riverine
retention ponds	✓	140 ac.± , riverine
reservoirs	____	

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Generally, by size and watershed area /

7. What design requirement is required for a structure in terms of allowable increases in backwater? Dependant on the type of structure, Zero (0) increase for bridge's & culverts.

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others...)? Rational Method, SCS methods (incl. TR-55 & 20), U.S.G.S. Method.

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No X, except ~~the U.S.G.S.~~ when design involves work in a floodplain, then calculations are compared to those developed and modeled by USGS.

10. To what extent does the community make use of high water marks to verify the correctness of its designs? When available, computations are compared to those developed and modeled by the USGS for NFIP floodplain mapping, which has been verified at various locations by high water marks.

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	✓	swales	✓
toe of slope channels	✓	dissipators	✓
outlet channels	✓		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? SCS Handbook, HEC-2.

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes X No ____ but rarely, and only when it involves a principal or floodplain mapped watercourse.

14. Does the community include freeboard in the design of its open channel structures?

Yes X No ____

If yes, what is it? Typically, 6" for smaller watershed areas, and 1' for principal watercourses and larger watersheds (+/-100 acre).

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational Method

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes X No ____ except for small, local watershed systems generally less than 25 acres.

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes X No ____ 10-yr. typical, and 25-yr. in sags of roadways.

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes X No ____

If yes, what are they?

Minimum pipe diameter = 15 inches.

Catch basin size = CT. DOT standards.

Spacing = 300-feet +/-.

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Erosion + sedimentation is generally controlled close to the source through hay bales, silt fence, and mulching. In-channel or stream dike are used as a last resort.

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

    Yes X No ____

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? except Generally, same as found in CT. DOT Drainage Manual.

22. Has the community had any particular problems with any of the drainage structures mentioned above?

    Yes ____ No X

    If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community Town of Bethel

2. Office(s) Contacted Public Works Department

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Public Works Dept

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes ✓ No ____

   for all open channels? Yes ✓ No ____ when practical

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	0
culvert	0
pipe	✓
retention ponds	0
reservoirs	0

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? flood frequency

7. What design requirement is required for a structure in terms of allowable increases in backwater? not a concern - no rivers in town

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)?
   Rational Method, TR55, proponent engineers discretion

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs?
    not at all

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects). None done since 1985 - no knowledge prior to that

top of slope channels	____	swales	____
toe of slope channels	____	dissipators	____
outlet channels	____		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? Not specified - left to designer

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ✓

14. Does the community include freeboard in the design of its open channel structures?

Yes 1 No ____

If yes, what is it? 1 foot

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational and TR55

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes drainage basin No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing? 15" min diam. 12" min diam for catch basin to catch basin

Yes ✓ No ____

If yes, what are they?

19. What types of controls does the community use to control erosion and sedimentation (e.g. sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? rip-rap, vegetative cover

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No X

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? Visual inspection during and after storms

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ✓ No ____

If yes, give an example and any attempts to rectify the problem.

Problem with requiring design or ^25 year storms for new subdivisions or for road upgrade, because Q ultimately enters drainage system which was designed for 10 yr storm. Causes flooding

* Note: Form was completed by Jeff Oakes of NAI based on notes taken at interview. Town had not completed form.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community City of Waterbury
2. Office(s) Contacted Bureau of Engineering - City Engineers Office
3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs City engineers office
4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes ✓ No____

   for all open channels? Yes ✓ No____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	0
culvert	0
pipe	0
retention ponds	0
reservoirs	0

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Storm frequency
7. What design requirement is required for a structure in terms of allowable increases in backwater? none - not known what was done prior to 1993
8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Rational Method and b
9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No ✓

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

    None - Don't know what was done in past

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	0	swales	0
toe of slope channels	0	dissipators	1
outlet channels	0		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? Federal Highway charts

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ____ No ✓

14. Does the community include freeboard in the design of its open channel structures?

Yes ____ No ✓

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational Method, HEC 2 for City wide study

16. Is stormwater analyzed on a drainage basin basis or just at the structural level? Historically on structural level

Yes ____ No ____ Presently On Basin Basis

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes ✓ No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing? Past - no

Yes ____ No ____ Presently min #15" Pipe diam.

If yes, what are they?

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Pools, settling basins

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes ____ No ✓

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?

None - Future city wide study is to be done

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ✓ No ____

If yes, give an example and any attempts to rectify the problem.

C. basin maintenance
undersized pipes
inadequate design

* Note: Form was completed by Jeff Oakes of NAI based on notes taken during interview. Town had not completed form.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community Windham, Connecticut

2. Office(s) Contacted Public Works

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Dept of Engineering

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986)? Yes

   for all drainage structures (bridges, culverts, pipes)? Yes X No ____

   for all open channels? Yes X No ____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	____
culvert	X
pipe	X
retention ponds	____
reservoirs	____

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? Size Flood Freq

7. What design requirement is required for a structure in terms of allowable increases in backwater? No increase. allowed

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)? Rational and SCS

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations? See Appendix

   Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs?

    We do not.

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	X
toe of slope channels	X	dissipators	____
outlet channels	X		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? Hydraulic Design Series 3 and 4.

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes ~~X~~ No X only on bridge

14. Does the community include freeboard in the design of its open channel structures?

Yes X No ____

If yes, what is it? One foot

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational and SCS

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes X No ____

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes X No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes X No ____

If yes, what are they?

Minimum pipe diameter 15 inches
Catchbasin size is per DOT standards
Catchbasin spacing is 300 feet maximum

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Silt fence and temporary silt pools

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes X No ____ We use Connecticut DOT standards

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)?
Refer to Connecticut DOT standards

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes ____ No X

If yes, give an example and any attempts to rectify the problem.

BRIDGE OPENING, CULVERT, AND STORMWATER
DESIGN STANDARDS AND PRACTICES
SAMPLE SURVEY

1. Name of Community Town of Litchfield

2. Office(s) Contacted Department of Public Works

3. Office(s) Responsible For Bridge, Culvert, and Stormwater Designs Department of Public Works

4. Does the community utilize existing standards, as provided in the Connecticut Department of Transportation's Drainage Manual (January 1986),

   for all drainage structures (bridges, culverts, pipes)? Yes X No____

   for all open channels? Yes X No____

Drainage Structures

5. Place a check next to the types of drainage structures that the community has designed and constructed within the last 15 years (not Federal or State projects). For each structure, provide information as to its maximum drainage area and whether it is located in a riverine or tidal environment.

bridge	X
culvert	X
pipe	X
retention ponds	____
reservoirs	____

6. How do you classify the drainage structures (i.e., by size: passing a certain discharge and corresponding flood frequency 10-year, 50-year, 100-year)? minor 50
   major 100

7. What design requirement is required for a structure in terms of allowable increases in backwater? HW/D = 1.5

8. How does the community determine expected or design runoff (e.g., use of Rational Method, SCS National Engineering Handbook, FHWA Method, U.S.G.S. Method, Storage and Routing Computations, others....)?
   (Rational method area < 200 acres) SCS TR55/TR20 area > 200 acres)

9. Does the community regularly utilize actual stream gage data or comparable stream data in its discharge calculations?

   Yes ____ No X

10. To what extent does the community make use of high water marks to verify the correctness of its designs? Observe and record high water levels

Open Channels

11. Place a check next to the types of open channels and accessories that the community has designed and constructed within the last 15 years (not Federal or State projects).

top of slope channels	____	swales	X
toe of slope channels	X	dissipators	X
outlet channels	X		

12. What method(s) are used by the community to design open channel structures (e.g., SCS National Engineering Handbook, Hydraulic Design Series No. 3 and 4, others...)? Hydraulic Design Series 3 & 4

13. Do designs include the development of water surface profiles, especially the before and after backwater effects involving other structures?

Yes X No ____

14. Does the community include freeboard in the design of its open channel structures? N/A

Yes ____ No ____

If yes, what is it?

Stormwater Systems

15. What method of analysis is used by the community to determine design flows for stormwater collection? Rational < 200 SCS TR55 > 200

16. Is stormwater analyzed on a drainage basin basis or just at the structural level?

Yes ____ No X

17. Are the stormwater conveyance structures categorized by size of event (e.g., 10-year, 50-year, discharge in cfs)?

Yes X No ____

18. Does the community have standards for pipe diameter, catch basin size and spacing?

Yes X No ____

If yes, what are they?

min pipe size (15") =>
min C.B. spacing (300 ft.)

General

19. What types of controls does the community use to control erosion and sedimentation (e.g., sedimentation dikes and pools, traps, soil stabilizers, slope analysis, chemical binders)? Silt Fence, Haybales, Geotextiles

20. Does the community have any designs for any of the drainage structures mentioned above that have been reviewed by an outside party (e.g., State DEP, Federal agency, private firm)?

Yes _____ No _X_

21. What design document format is utilized by the community for the various types of drainage structures (provide an example of each)? Attached

22. Has the community had any particular problems with any of the drainage structures mentioned above?

Yes _____ No _X_

If yes, give an example and any attempts to rectify the problem.